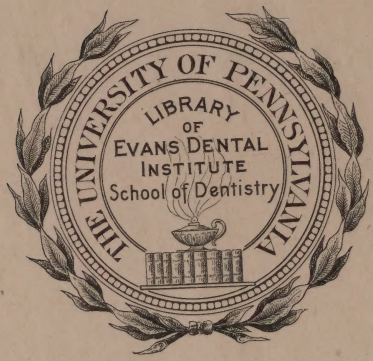
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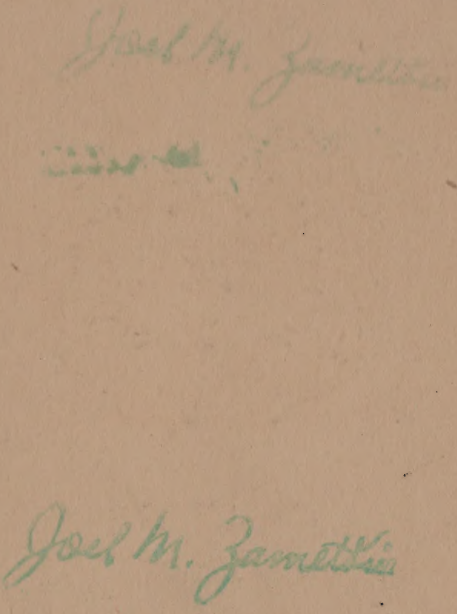

MODERN DENTAL MATERIA MEDICA, PHARMACOLOGY AND THERAPEUTICS

BUCKLEY

Modern Dental Materia Medica, Pharmacology and Therapeutics

INCLUDING THE PRACTICAL APPLICATION OF DRUGS AND REMEDIES IN THE TREATMENT OF DISEASE

BY

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FIFTH EDITION, REVISED

TWO HUNDRED FIVE ILLUSTRATIONS

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TO
THE MEMORY OF
MY MOTHER,
WHOSE ENCOURAGEMENT IN MY BOYHOOD DAYS
SERVED ME SO WELL,
AND TO
MY WIFE,
FOR MANY WILLING SACRIFICES DURING THE
PAST TWENTY SEVEN YEARS,
THIS VOLUME IS FONDLY
DEDICATED.

13387

PREFACE TO THE FIFTH EDITION

This book has been thoroughly revised and much of the text rewritten. Part I in accordance with the United States Pharmacopeia X, which became official January 1, 1926.

The adoption of the designation "mil," abbreviation for milliliter, in the U.S.P. IX never became popular. The Committee on Revision, therefore, decided to return to the almost universally used term "cubic centimeter" (cc.) in the U.S.P. X. The abbreviation (cc.) is used throughout the text of this Edition; though it should be remembered that the cubic centimeter of the Pharmacopeia as here used represents a milliliter—the one-thousandth part of a liter. Such additions, deletions and changes in official Latin and English titles of the U.S.P. X, as in the author's judgment are of interest to dentists, have been carefully noted. Other changes and additions have been made in the first part of the book as will make it contain the latest knowledge and conform to the advances made in the subjects of Materia Medica and Pharmacology.

Biologic therapy is employed today more than ever before and accordingly the text relating to Biologic Products has been extended and covers the subject in greater detail than the previous Edition. The subjects of Food and Diet, in their relation to dentistry, has also been thoroughly considered. For information on these important subjects the author is indebted to the Research Laboratories of Eli Lilly and Company, of Indianapolis.

During the past few years there has been much speculation in the field of Dental Therapeutics. At times the conscientious practitioner of dentistry seriously questioned whether it was worth while to make an attempt to treat and save a tooth which was pulpless or had an infection of any character associated with it. But a saner and broader view is taken today, with the assured result that there is every evidence of a gradual drifting back to the former methods of treating the conditions under consideration in Part II of this work—with certain important advances which have been considered in this revision. The method of treating teeth by silver reduction has been included, with such other methods as have been tried in practice and found to possess merit.

The author's thanks are due Dr. Percy R. Howe, of Boston, for his description of the silver reduction method; also Drs. Chas. G. and Ralph R. Hartley, of Los Angeles; Drs. Fred W. Gethro and L. E. Bake, of Chicago; Dr. Geo. H. Mengel, of El Paso; and Dr. J. M. Thompson, of Detroit, for illustrated cases from their practice. For practical suggestions throughout the text credit is also due Dr. P. G. Puterbaugh, of Chicago, the author's associate in teaching the subjects of Materia Medica and Therapeutics in the Chicago College of Dental Surgery. Walter Booth Adams, M. D., Professor of Materia Medica and Syphiology in the Dental Department of the American University of Beirut, Syria, took occasion to read carefully the entire book, making such notations as he felt would improve the work; and, though a stranger in a far-away land, sent the notations to the author. For his suggestions and kindly considerations thanks are especially due. Once again the author desires to record his appreciation of the cordial reception the work has received from the profession in general and from dental teachers of the subject in particular. The unfailing courtesy of the publisher at all times is both encouraging and appreciated.

Los Angeles. J. P. Buckley.

PREFACE TO THE FOURTH EDITION

This book has been rewritten and thoroughly revised; Part I in accordance with the United States Pharmacopeia IX, which became official on September 1, 1916; and Part II in accordance with the knowledge of to-day relating to the treatment of diseases of the teeth and associated structures.

The U.S.P. IX has discarded the term cubic centimeter (abbrev. c.c.) on the ground that the United States Bureau of Standards declared the term a misnomer, there being a slight difference between the thousandth part of a liter and a cubic centimeter. The word mil, the first three letters of the whole word milliliter, has been adopted; therefore, in this work the word mil is used instead of c.c.

The National Formulary is referred to in this edition more than was done heretofore, for the reason that many valuable pharmaceutical preparations have been omitted from the U.S.P. IX, and are found in the N.F. The laws passed by various States of the Union, in conformity with the National Food and Drugs Act which was passed by Congress on June 30, 1906, make both the United States Pharmacopeia and the National Formulary the standards for drugs.

An effort is being made in the profession of dentistry to-day to treat teeth under as nearly aseptic conditions as possible. With this end in view an article on Dental Sterilization has been written; as has also an article on Biologic Products. The advanced therapy of many infectious diseases includes the intelligent use of products from the Biologic Laboratories. Many of the systemic diseases of this character are now known to have a direct relation to diseased mouth and throat conditions; therefore, it is important that the student and the practitioner of dentistry understand the principles upon which this therapy is based.

It will be found that Part II, which deals with Dental Therapeutics, is more profusely illustrated than in former editions. There is no problem in dentistry at the present time of greater importance than the treatment of pulpless teeth and their sequelæ. On this particular subject many illustrations have been added which show results of the treatment after the methods described in the text.

The colored illustrations, especially those relating to the diseases of the soft tissues of the mouth, will aid greatly in the recognition of these diseases as they present in practice.

The author is indebted to Prof. John F. Biddle, of the Dental Department of the University of Pittsburg, for illustrated cases in his practice; and also desires again to record his appreciation of the cordial reception which this book has received from dental teachers of the subject, and from the profession at large.

CHICAGO. J. P. BUCKLEY.

PREFACE TO THE THIRD EDITION

The printing of the third edition in twenty months after the first appearance of this book has enabled the author to again make such alterations and corrections as would enhance the value of the work. The text has been changed slightly throughout and several new and original illustrations have been added. The greatest change has been made in the treatment of chronic alveolar abscess. Dentists in the past have placed too much dependence in drugs as the means of correcting root and bone complications; and, as a result, many teeth, thus diseased, have been needlessly extracted. Therefore the surgical treatment of these complicated conditions has been considered more fully and new illustrations added to aid in both the diagnosis and treatment. It has been my desire to improve the book without enlarging it, and to make the text still more clear, direct and practical.

CHICAGO. J. P. BUCKLEY.

PREFACE TO THE FIRST EDITION

The general plan of this book is the outgrowth of many years of experience as a dental practitioner and teacher of Materia Medica, Pharmacology and Therapeutics in dental colleges. During these years, the author has realized the need of a text-book which would meet the wants of teacher, student and practitioner.

The book is intended to include all that a dentist should know about drugs and remedies and their practical application in the treatment of disease.

The work is divided into two parts. The first is devoted to Materia Medica and Pharmacology, with enough Therapeutics to indicate clearly the uses of the various drugs and remedies; and an effort has been made to include herein every drug or remedy which is employed in Dental Therapeutics, except those which are obsolete, untried or savor of the "secret formula" variety. To accomplish this end, it was, of course, necessary to consult freely the United States Pharmacopeia, and other standard works on these subjects.

Drugs marked with an asterisk (*) mean that the drug is a member of the group under consideration, but because of other properties which the agent possesses, it has been elsewhere considered. In most instances, the drug is discussed under the group in which it is first mentioned, and if it is referred to subsequently in another group, it is there marked with an asterisk. For example, phenol is mentioned first as a disinfectant under which group of drugs it is discussed. Later it is mentioned in the group of escharotics, and is there marked with an asterisk.

In this part of the book, also, is included Prescription Writing and its associated subjects—Metrology, Medical Latin and Incompatibility, all of which have been given the dignity and importance they deserve in a dental course. It will be observed that no prescriptions have been written until after Prescription Writing has been discussed; after which, however, no formula has been mentioned without a correctly written prescription for the same. This plan was followed for the benefit of teachers and students in dental colleges. Prescriptions, as a rule, are confusing, though enticing to beginners, and questions naturally suggest themselves in regard to the various signs and terms used. For the teacher to attempt to explain these before the subject proper had been studied would be a loss of time, as no one can write a prescription intelligently without first being

familiar with drugs. Therefore, it is better, in the author's opinion, to avoid even the suggestion of questions pertaining to prescriptions at this time. By thus deferring the study of Prescription Writing to about the close of the Junior year, an excellent opportunity is afforded for practice work throughout the entire Senior year when Practical Therapeutics is taught. By this means only can students become good prescription writers—a faculty not developed by the average dentist.

The second part of the book is devoted to Practical Dental Therapeutics. In writing it the author was actuated by the belief that Dental Therapeutics is of sufficient importance to occupy a place in dentistry by itself. It is to be hoped that this subject may ultimately be divorced from Operative Dentistry, to which it has long been subordinated.

No attempt has been made to describe all of the many methods of treatment, nor to give the endless formulas suggested in the various text-books and journals, for the pathologic conditions mentioned herein. To do so would lead to confusion, as well as make the book unnecessarily voluminous, in which case the word "practical" in connection with "therapeutics," as used here, would be a misnomer. Therefore, in most instances, only the methods by which the conditions are treated in the author's own practice are detailed. These methods, of course, are not wholly original. They have been gleaned from clinical experience, from extensive reading, and from observation and association with other practitioners; and in both private and infirmary practice they have given good results.

The prescriptions for remedies, for the most part, are original with the author, and have been worked out along the lines of practical pharmacy and therapeutics. Where the formulas are not original, due credit, so far as is known, has been given.

It is unnecessary to profusely illustrate a book of this kind. Only such illustrations as will tend to better explain the subject matter of the text are given. These, with few exceptions, were taken from actual cases in the author's practice, or from private patients referred to him for treatment.

The author desires to express his grateful appreciation to Dr. E. W. Elliot for valuable suggestions, to Dr. Lee K. Stewart for furnishing models to illustrate a practical retaining appliance, and to other professional friends for the encouragement given in undertaking the work. He further records his appreciation of the publisher's unfailing courtesy.

J. P. Buckley.

Chicago.

CONTENTS

PART I

DENTAL MATERIA MEDICA AND PHARMACOLOGY

Modern Dental Materia Medica, Pharmacology and Therapeutics, 1
General Considerations, 1
Sources of Drugs and Constituents of Those of Vegetable Origin, 5
Parts of Plants Used for Drugs, 7
Drug Culture, 8
Pharmaceutic Preparations, 11
The Solutions, 11
The Mixtures, 15
Products by Extraction, 16
Mixtures of Solids, 20
Preparations for External Use, 22
Miscellaneous List of Nonofficial Bandages, Splints, Medicated and Antiseptic Dressings, and Medicated Gauzes, 24
Methods of Administering or Applying Drugs, 25
By the Mouth, 25
Hypodermic, 26
Epidermic or Inunction, 29
Intravenous, 29
Cataphoresis, 29
By the Rectum, 30
Inhalation, 30
Conditions Modifying the Action and Effect of Drugs, 30
Habit, 30
Idiosyncrasy, 31
Tolerance, 31
Cumulative Effect, 31
Dosage or Posology, 31
Age and Sex, 32
Pathologic Conditions, 32
Method and Time of Administration, 33
Classification of Medicines, 33
Definitions of Remedies, 34
Foods, Hematics, and Tonics, 38
Drugs, 39
Local Remedies, 40
Antacids, 40
Antiseptics, Disinfectants, and Deodorants, 45
Astringents, Styptics, and Hemostatics, 84
Other Silver Salts and Soluble Compounds, 101
Bleachers, 103
Oxidizing Agents, 103

Escharotics or Caustics, 109
Irritants and Counterirritants, 122
Emollients, Demulcents, and Protectives, 132
Local Anesthetics, 142
Refrigerant and Paralyzant, 142
General Anesthetics, 158
Antipyretics, 164
Hypnotics, 169
Narcotics, 176
Stimulants, 183
Cardiac, 183
Respiratory, 196
Gastric, 198
Miscellaneous Group, 201
Alteratives and Restoratives, 203
Digestants, 229
Cathartics, 232
Diuretics, 247
Diaphoretics, 253
Emetics, 255
Expectorants, 259
Sialogogues, 260
Carminatives, 261
Flavoring Agents, 265
Biologic Products, 270
Antitoxins, 272
Serums, 273
Indications for Serums, 274
Vaccines, 274
Indications for Vaccines, 274
Food and Diet, 278
Vitamines, 279
Sources, 279
Results of Vitamine Deficient Diets, 280
Need for Available Vitamine Preparations, 283
Diet of Infants, 284
Standards for Vitamine Preparations, 285
Tests for Vitamines A, B, C and D, 285
Standardized Vitamine Products, 289
Remedies Other Than Drugs, 293
Heat, 293
Cold, 294
Compressed Air, 295
Light, 295
Röntgen or *x*-ray, 296
Radium, 297
Electricity, 297
Massage, 298
Suction, 298
Suggestion, 299
Metrology, 301
The Metric System, 303
Equivalents to the English Weights and Measures, 305
Percentage in Solutions, 307

Prescription-writing, 308
Medical Latin, 313
Examples of Practical Prescriptions, 315
Incompatibility in Prescriptions, 319
Antagonism of Drugs, 321
Dental Sterilization, 322
General Considerations, 322
Methods of Dental Sterilization, 322
Direct Flame, 323
Moist and Dry Heat, 323, 324
Chemic Agents, 324

PART II

PRACTICAL DENTAL THERAPEUTICS

General Considerations, 327
Diseases of the Hard Tissues of the Mouth and Associated Structures, 329
Hypersensitive Dentin, 329
General Considerations, 329
Previous Attempts at Controlling Pain, 330
Therapeutics, 331
I. Physical Agents, 331
Heat, 331
Cold, 332
Light; Electricity, 333
II. Escharotics or Caustics, 333
Phenol and Zinc Chlorid, 333
Trichloracetic Acid, Silver Nitrate, and Trioxymethylen, 334
III. Local Anodynes or Local Anesthetics, 335
Cocain, 335
Procain, 336
Neothesin, Menthol, Oil of Cloves, Eugenol, Phenol, Ethyl Chlorid, Ether, and Chloroform, 337
IV. General Anodynes or Analgesics, 337
Opium, the Bromids, Nitrous Oxid, and Chloroform, 338
Desensitizing Paste, 339
Physiologic Action, 340
Indications, 340
Making the Application, 341
Precautions, 342
Caution in Relation to Diseased Pulps, 342
Diagnosis and Treatment of Diseases of the Dental Pulp; including the Destruction and Removal of the Organ, 344
General Considerations, 344
The Normal Dental Pulp, 344
Character of Blood-vessels, 345
Common Sources of Irritation, 345
Constructive Diseases, 348
Secondary Dentin, 348
Pulp Nodules, 349
Destructive Diseases, 352
Diagnosis of Active and Passive Hyperemia and True Pulpitis, 353
Differential Diagnosis, 354
Treatment of Active Hyperemia, 354

Factors to be Consideed in Pulp Capping, 354
Exceptional Cases of Exposure, 355
Therapeutics of Pulp Capping, 356
Precautions, 356
Technic, 357
Treatment of Passive Hyperemia and True Inflammation, 360
The Removal of Vital Pulps and Subsequent Treatment, 363
General Considerations, 363
General Factors to be Observed in Removal of Pulp, 364
I. Anesthetization, 364
1. Pressure Anesthesia, 364
Sterilization, 365
The Solution, 366
Pressure, 367
Confining the Solution under Pressure, 368
Opening the Pulp Chamber to Expose Canals, 368
Selecting and Testing Broaches, 369
Control of Ordinary Hemorrhage and Removal of Blood, 370
Small Canals, 371
After-treatment, 371
When to Fill Canals, 372
Excessive Hemorrhage, 372
Objections to the Use of Adrenalin Chlorid, 373
2. Cataphoresis, 373
II. Devitalization, 374
The Preparation, 376
Technic of Application, 377
Length of Time Application Should Remain, 377
Opening Pulp Chamber and Exposing Canals, 378
Objections to the Use of Dialysed Iron and Tannic Acid, 379
Complications, 379
Hypertrophied Gum Tissue, 379
Diagnosis as to the Kind of Tissue in Cavity, 381
Hypertrophied Pulp Tissue, 381
Secondary Dentin, Pulp Nodules, and Pulp Calcification, 381
Removal of Pulps from Deciduous Teeth, 382
Arsenical Poisoning, 383
Chemistry of Pulp Decomposition, 386
General Considerations, 386
Chemic Composition of Animal Tissue, 387
Nitrogenous Substances, 387
Nonnitrogenous Substances, 388
Pulp Decomposition, 389
Intermediate Products, 389
1. Ptomaines, 389
2. Amido-acids, 390
End-Products, 390
Diagnosis and Treatment of Pulpless Teeth and their Sequelæ; including the Preparation of the Canals for Filling, 392
General Considerations, 392
Coagulating Drugs, 395
Important Products of Pulp Decomposition, 395
Drugs Indicated, 396
Factors to be Considered, 397

Diagnosis of Dead Pulps, 397
Treatment of Pulpless Teeth, 398
Potassium and Sodium, 399
Technic of Using Schreier's Alloy, 399
Rationale of Rhein's Method, 400
Advantages of Phenolsulphonic Acid, 402
Caution in Using Callahan's Method, 403
Technic of Using Acid Method, 403
Nonpurulent Variety, 404
Removing old Root Filling, 406
Removing Blockade in Canal, 406
Purulent Variety, 407
Ionization, 408
Ionic Theory, 408
Howe's Method of Treating Pulpless Teeth, 410
Preparation for Material, 411
Instruments for Application, 412
Principles of Its Use, 412
Method of Procedure, 413
Complications, 415
Badly Decayed Root, 415
Pulp Partially Alive, Pulpal Abscess, Dry Gangrene, 415, 416
History and Treatment of Practical Cases, 416
Diagnosis and Treatment of Nonseptic Pericementitis, 429
General Considerations, 429
Drug Irritants, 429
Mechanical Irritants, 431
Treatment of Nonseptic Pericementitis, 432
Diagnosis and Treatment of Septic Pericementitis and Acute Alveolar Abscess, 435
General Considerations, 435
Local Treatment, 435
General Treatment, 436
The Question of Extraction, 439
Chronic Alveolar Abscess, 441
General Considerations, 441
1. Abscess without Sinus, 442
Disposing of the Pus, 442
Therapeutics, 443
Weeping of Serum, 444
Complications, 444
2. Abscess with Sinus, 445
Therapeutics, 445
Establishing Sinus and Disposing of Pus, 446
Cauterizing Sinus, 446
Complications, 448
1. Denuded End of Root, 449
2. Resorbed or Roughened End of Root, 450
3. Encystment of Root, 451
4. Involving Bone, 451
5. Extensive Caries or Necrosis, 451
6. Involving Vault, 453
7. Secondary Abscess Pocket, 453

8. Involving Two or More Teeth, 453
9. Involving Antrum, 454
Periapical Cysts, 454
Surgical Treatment of Chronic Alveolar Abscesses and Their Sequelæ, 454
Indications for Surgery, 454
The Anesthetic; Incision and Control of Hemorrhage, 455, 456
Exposing the Area Involved, 457
Curetting the Area, 458
Filling End of Root, 458
Washing and Packing the Wound, 459
Subsequent Treatment, 459
Treatment of Gangrenous Pulps and Abscesses in Deciduous Teeth, 466
Pericemental Abscess, 468
Therapeutics, 468
Filling Root-canals, 471
Precautions, 473
Callahan's Rosin Solution, 477
Technic, 478
Discolored Teeth, 484
Principle of Bleaching, 485
Methods of Bleaching, 489
Oxidation, 489
Reduction, 490
Using Sodium Dioxid, 490
Preparation of the Tooth, 406
Ethereal Solution of Hydrogen Dioxid, 492
Antrum of Highmore, 495
Causes of Diseases of the Antrum, 495
Diagnosis, 497
Therapeutics, 498
Surgical Treatment, 498
Medicinal Treatment, 499
Pyorrhea Alveolaris, 501
Probable Causes, 501
Systemic Effects, 502
Description of Classes, 505
Therapeutics, 507
Surgical Treatment, 509
Medicinal Treatment, 514
Astringent Mouth-washes Contraindicated, 515
Mechanical Treatment, 526
Neuralgia, 531
Trifacial Neuralgia, 532
Therapeutics, 532
Medicinal Treatment, 534
Local, 534
General, 535
Surgical Treatment, 538
Tic Douloureux, 538
Diagnosis and Treatment of Diseases of the Soft Tissues of the Mouth not Directly Associated with the Teeth, 540
General Considerations, 540
Canker Sores, 541
Herpes Labialis, 542

Syphilis, 542
Primary, 543
Secondary, 545
Tertiary, 547
Mercurial Stomatitis, 548
Tuberculosis, 549
Leucoplakia Buccalis, 550
Actinomycosis, 551
Acute Ulcerous Gingivitis, 552
Vincent's infection, 454
Ludwig's Angina, 555
Gonorrhea, 557
Examination of Urine, 558
Total Solids in Normal Urine, 559
Urine Analysis, 561
Fehling's Solution, 561
General Index, 563

PART I

MODERN DENTAL MATERIA MEDICA, PHARMACOLOGY AND THERAPEUTICS

Materia medica is the science that treats of drugs, the study of which includes the source. constituents, physical and chemic properties of the inorganic and organic materials used for drugs.

Pharmacology is the science that treats of the *action* of drugs upon the tissues, organs and functions of the body. It is, therefore, the study of the changes induced in living organisms by the administration of such substances as do not act as foods. Formerly this science was called *Pharmacodynamics*. That part of Pharmacology devoted to the study of Poisons is called *Toxicology*.

Therapeutics is the science that deals with the *application* of drugs or remedies to the treatment of disease.

The treatment of disease based solely on clinical experience, whereby remedies are administered or applied without reference to their physiologic action, is known as *empirical therapeutics*. The application of the essential oils to the canals of teeth containing gangrenous (putrescent) pulps, or the giving of salicylic acid, sodium salicylate or the lithium salts in cases of pyorrhea alveolaris, supposed to be associated with rheumatism or gout, are examples of empirical therapeutics.

The treatment of disease by the employment of drugs which, from a knowledge of their physiologic actions, are expected to counteract certain known pathologic conditions, is recognized as *rational therapeutics*. The application of remedies containing formaldehyd to a gangrenous root-canal, wherein it is expected that the formaldehyd gas will neutralize the gaseous end-products of pulp decomposition, may be given as an illustration of rational therapeutics.

While it is essential that the student should understand at the very outset the definition of the terms *materia medica*, *pharmacology* and *therapeutics*, it is also essential that other general terms used throughout the text should be thoroughly mastered at this time.

A medicine is any substance used in the treatment of disease. Medicines differ from foods in that the latter furnishes material with

which some structure of the body is rebuilt or some vital process is maintained. In other words, foods enter constructively into the composition of the cell; medicines do not—they simply modify vital processes according to the manner in which they are used in therapeutics.

A drug is any substance which may be used as a medicine, or it may be used purely in chemic processes and not directly in the treatment of disease.

A remedy is a broader term and includes, besides material substances, such agents or means employed in therapeutics as heat, cold, light, electricity, massage and suggestion. Remedies, therefore, may be divided as follows:

Prophylactic Remedies.—Those used to prevent disease, as polishing tooth-surfaces to prevent caries, vaccination to prevent smallpox, or serums to prevent typhoid fever. For the most part these remedies are relative in their effect, not absolute.

Hygienic Remedies.—Those that assist in the maintenance or promotion of health, such as pure air, water, food and bathing; relating to **hygiene,** which is the science of health.

Imponderable Remedies.—These include heat, cold, light, electricity, X-ray, radium, massage and suggestion.

Mechanical Remedies.—These involve the use of bandages, splints, instruments, etc.

Pharmacologic Remedies.—These are called also *medicinal remedies* and are the material substances or medicines used in the treatment of disease.

Biologic Remedies.—These are bacteriologic and chemic products obtained from the biologic laboratories, and are known as serums, vaccines and antitoxins.

In recent years an effort has been made to unify the theory and standardize the practice of every branch of dentistry. Uniformity in methods is the object sought. It is equally important that there should be uniformity in the use of terms. There is nothing that more truly reflects the dignity and character of a cultured and learned profession than a due regard for the significance and correct use of terms. There are several closely related terms employed in the study of the practical uses of remedies, which often lead to confusion. It is well that the student understand these terms at the very outset. The term **specific** has a double meaning. When used in connection

with a remedy it means that the remedy, if used in the proper manner, can generally be depended upon to produce definite results in certain diseases. For example, formocresol is a specific for gangrenous pulp conditions; antitoxin is a specific for diphtheria, and quinin for malaria. There are but few specific remedies. Applied to a disease, the term specific means syphilis, and it is so used by physicians and dentists to indicate that disease which has associated with it the stigma of vice. Therefore, syphilis is generally spoken of as a **specific disease,** and such remedies as salvarsan, neosalvarsan, mercury and the iodids are considered specifics for its treatment.

The terms **physiologic action, physiologic effect** and **therapeutic effect** are too frequently used interchangeably, without reference to their true meaning. There is a distinction between the action and the effect of a drug. Many times the action of a drug is obscure for it relates to structural changes in the cell; but the effect if produced, must necessarily be apparent as it involves a change in function. This is nicely illustrated by the inhalation of ammonia in cases of syncope (fainting). The *action* of the ammonia gas is that of an irritant on the respiratory mucous membrane, while the *physiologic effect* desired in this instance is cardiac and respiratory stimulation. This is brought about reflexly by the local irritation; for ammonia, thus administered, produces a marked increase in both the strength and rapidity of the pulse and the depth and rapidity of the respirations. In the case mentioned above, the *therapeutic effect* would be the return of consciousness, which might not follow without further treatment. It is, therefore, possible to have the physiologic action and effect of a drug without the therapeutic effect.

Resolution is a term which indicates the return of an abnormal to a normal condition, and means structural recovery. **Dissolution** is a term which means death.

The author desires here to emphasize the importance of learning the distinction between these several terms, for they are too often used synonymously, without reference to their true meaning.

A poison is any substance which, when administered or applied, by its inherent physical or chemic properties causes disease or death. That branch of medical science which treats of the action and effects of poisons, their detection, and the treatment of the conditions resulting therefrom, is called *Toxicology*.

Pharmacy is the art of preparing, compounding and dispensing medicines.

The Pharmacopeia is an authoritative work which: (1) Establishes *standards* and *tests* for the identification, quality, purity and strength, and (2) gives *directions* for the preparation, purification and preservation of drugs and medicines. How to prepare, purify and preserve medicines is the work of the pharmacist, but every practicing dentist should be familiar with certain standards and tests for the identity, quality, purity and strength of the medicines employed in daily practice.

The pharmacopeias may be considered the medico-legal authorities for drugs and medicines in their respective countries.

The United States Pharmacopeia (abbreviation, U.S.P.) is prepared by a committee consisting of delegates appointed by authority from regularly incorporated medical and pharmaceutic societies and colleges. This pharmacopeial committee meets at the beginning of each decade, and the code of remedial agents thus established is intended to serve as a standard until superseded by a new revision. The last (tenth x) edition of the U.S.P. became the official standard January, 1, 1926. This book has been thoroughly revised in accordance therewith. By admitting certain articles to the pages of the U.S.P., it declares them to be of sufficient importance as to merit confidence in their use in the practice of medicine. Articles thus recognized are known as "official," which is synonymous with "pharmacopeial." Such articles must conform to the tests, assays, and requirements of the Pharmacopeia. This should not be taken to mean that articles not admitted are valueless, for there are many formulas in common use to-day which are exceedingly valuable, though not official.

National Formulary (abbreviation, N.F.) is a collection of formulas issued by the American Pharmaceutical Association as a supplement to the United States Pharmacopeia.

Food and Drugs Act is a National law, which was passed by Congress on June 30, 1906. This was soon followed by similar legislation in the various States of the Union. These laws make the United States Pharmacopeia and the National Formulary the standards for drugs. The National Act states:

"The term 'drug,' as used in this Act, shall include all medicines and preparations recognized in the United States Pharmacopeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals." This legislation has been the means from which a great improvement in the quality of medicines has resulted.

On account of the recognition given the National Formulary by the Food and Drugs Act, many formulas heretofore included in the previous Pharmacopeias have been omitted in the ninth and tenth editions. These formulas are now found in the National Formulary; and whenever occasion requires, throughout this work, reference will be made to this standard authority, though the official preparations, or a combination of two or more, will largely furnish the basis for the formulas given by the author in that part of the book devoted to practical therapeutics.

A dispensatory is a commentary on the pharmacopeia, including, as do the American Dispensatories, all information pertaining to the pharmacy as well as the action and uses of medicines. Dispensatories are private publications, and should be used only as references, for they are not intended to take the place of the standard and legal authorities—the Pharmacopeia and National Formulary.

SOURCES OF DRUGS AND CONSTITUENTS OF THOSE OF VEGETABLE ORIGIN

Drugs are derived from the three kingdoms of nature—*mineral*, *animal* and *vegetable*. Those which belong to the mineral kingdom are called *inorganic drugs*, and are obtained by chemic processes directly from nature. Many valuable drugs are made by *synthesis*—the artificial formation of the product by chemically combining its constituents. Those so made are known as *synthetic drugs*. *Organic drugs* are those which are taken from the animal and vegetable kingdoms. The element, *carbon*, plays the leading rôle in all organic drugs, and is combined in the compounds of carbon with such elements as *hydrogen*, *oxygen*, *nitrogen*, and others. A great many medicinal products are being produced by biologic processes. They include the various *serums*, *vaccines* and *antitoxins*. A *serum* for therapeutic use is a product obtained from the blood of an immunized animal. A *vaccine* is any substance used for preventive inoculation, and is obtained in various ways—as lymph from a cowpox vesicle; from the patient himself. A vaccine made from a bacterial culture obtained from the patient is known as an *autogenous vaccine*. An *antitoxin* is a counterpoison or antidote elaborated by the body to counteract the toxins of bacteria. Antitoxins are frequently used in the treatment of certain infectious diseases, and also to confer immunity against these diseases.

The constituents of vegetable drugs of value in medicine and dentistry are called *the active principles*, and they include carbohy-

drates, alkaloids, glucosids, neutral principles, organic acids, volatile oils, resins, gums, fixed oils and fats, camphors and other miscellaneous compounds.

Carbohydrates are largely used as foods, yet many of them, owing to their bland and soothing action, are employed as medicines. These include *starch* and the *sugars*.

Alkaloids are nitrogenous compounds, having the reaction and basic properties of alkalies. They are odorless, have a bitter taste, and generally possess powerful physiologic actions. Alkaloids are almost insoluble in water, but they readily combine with acids to form crystallizable salts which are freely soluble. For example, *cocain* is an alkaloid, and, as such, is not largely used in dental practice; but, when acted upon by hydrochloric acid, cocain hydrochlorid is formed, and this alkaloidal salt is one of our most useful drugs.

Other examples of alkaloids are, *strychnin*, *morphin*, *atropin*, etc. The term *artificial alkaloid* is used to designate secondary alkaloids derived from natural ones, as *apomorphin*, which is obtained by abstracting from morphin a molecule of water.

Glucosids comprise those vegetable principles which may be resolved by boiling with dilute acid or alkalies, or by the action of ferments, into glucose and one or more other products peculiar to the substance tested. *Glycyrrhizin*, obtained from liquorice-root, and *salicin*, from willow-bark, are examples.

Neutral principles are neutral constituents, differing from alkaloids in not being basic in character and from glucosids in not being resolvable into glucose. *Aloin*, from aloes, and *piperin*, from black pepper, are examples.

Organic acids are found in many plants, either free or combined with alkaloids or inorganic bases. Those of most value in dentistry are *acetic*, *benzoic*, *lactic*, *salicylic*, *oxalic*, and *tannic* acids.

Volatile oils, also called *essential oils*, form a large group of organic bodies, from which they are chiefly obtained by distillation. They are highly odorous, oily, sparingly soluble in water, more or less soluble in alcohol and ether, and prone to become resinous on exposure to air. In the past the volatile oils have occupied a prominent place in dental practice. Those to be remembered are the oils of *cassia* (*cinnamon*), *cloves*, *peppermint*, *wintergreen*, *turpentine*, *eucalyptus*, and *cajuput*.

Resins are exudations associated with, and probably derived from, volatile oils. They are insoluble in water, but freely soluble in alcohol. Examples of resins are those of *jalap*, *podophyllum* and *common rosin*. When a resin and volatile oil are both constituents

of the same drug, the former is held in solution by the latter, making a *natural oleoresin*.

Gums are dried exudations obtained by incising the limbs and branches of certain plants. Gums, contrary to resins, are insoluble in alcohol, but freely soluble in water. The most important gums are those of *acacia* and *tragacanth*. Ordinary mucilage is a solution of certain gums in water.

Fixed oils and fats are obtained by simple pressure, and are not readily volatilized. Those used chiefly in dentistry are *lard*, *lard oil*, *olive oil*, *castor oil*, and *oil of theobroma* (*cacao butter*).

Camphors are solid and crystallizable bodies, closely associated in plants with *terpenes*, *i.e.*, compounds of carbon and hydrogen in the proportion $C_{10}H_{16}$, and probably derived from them by oxidation. The principal member of the group is official camphor, $C_{10}H_{16}O$. *Stearoptenes*, obtained from various essential oils, as *menthol* and *eucalyptol*, are sometimes called camphors, but should not be so considered.

Miscellaneous compounds are such proximate principles as are not referable to the groups mentioned. They include several compounds of value to dentistry, as *eucalyptol*, *eugenol*, *thymol* and *guaiacol*.

PARTS OF PLANTS USED FOR DRUGS

The crude organic drugs which form a large part of the materia medica are chiefly derived from the vegetable kingdom. All the different parts of plants are used. The active principle is often distributed throughout the entire plant, but is generally found more abundantly in one particular part, which is then used. For convenience in study, the *parts of plants used for drugs* can be divided into portions which grow *under* and *above* the ground.

Portions Under Ground.—The *root* (*radix*) proper is that part of the plant-axis which does not bear leaves. Roots are ordinarily subterranean (grow underground) in their habits, and serve the double use of attaching the plant securely to the soil and of enabling it to absorb from the latter the necessary food. The roots of some plants not only perform these functions, but become greatly thickened and serve also for the accumulation of reserve food material and are then called *tubers* (potato, beet and turnip). Roots possess a bark which is sometimes used separately (sassafras). If the underground portion of a root does bear leaves, it is termed *rhizome* (*rhizoma*). This is sometimes called a subterranean stem. When the

root-leaves become enlarged and serve as storehouses for food, a *bulb* (*bulbus*) is formed. The onion is an example. The lowest part of the stem of a plant is often thickened, and is then called *corm* (*cormus*).

Portions Above Ground.—When the entire plant, except the root is employed, it is called *herb* (*herba*). This consists of stems, leaves, and often flowers or fruit.

The *stem* proper is that part of the plant-axis which bears leaves or some modification of them. Its functions are, to form such a support for the leaves as will duly expose them to the influence of light and air, to bear the floral organs and convey to them the necessary nutriment, and to form a means of communication and interchange between the roots, or organs which absorb the crude nutritive material from the soil, and the leaves, or organs which assimilate this food. With small, herby plants the stem is called *stipes;* with larger plants it is transformed into *wood* (*lignum*) and is covered with *bark* (*cortex*). The outer layers of the older bark are always corky, and a secondary bark develops inside of this which is called *liber*.

The *leaves* (*folia*) are stem-appendages, regularly arranged upon the stem, and consist of expansions of its tissues. *Buds* may be considered as rudimentary stems, with rudimentary leaves compactly arranged upon them.

The *flower* (*flos*) is a special modification of the leaves. It consists of the *calyx* (usually green parts called *sepals*) and a *corolla*. The latter is made up of showy leaflets (petals) and the inconspicuous, but important, male and female elements called *stamens* and *pistil*, respectively. The stamens bear the fertilizing element in the form of granules, termed *pollen*. The pistil consists of the *ovary*, which develops the *seed* (*semen*), and the *style* and *stigma*, which serve to receive the pollen. After fertilization takes place, the ovary develops into the *fruit* (*fructus*); this may also involve neighboring parts, especially the top of the stem, as in the apple and strawberry. The fruit consists of the outer portion, *pericarp*, and the seeds. The latter contain the embryo and nutriment material, and are protected by a more or less hard shell. Certain organic drugs consist of the coagulated *juices* of the plants and show no structure (opium, etc.).

DRUG CULTURE[1]

The past decade has witnessed a marked change in the attitude toward drug cultivation. Prior to that time drug cultivation consisted for the most part in removing medicinal plants from their

[1] Hand Book of Pharmacy and Therapeutics—Lilly, Sixth Edition.

natural habitat and growing them under cultural conditions. Today, the efforts to produce medicinal plants have become more stabilized and have resolved themselves into systematic attempts to improve medicinal plant cultivation by intensive methods of breeding and selection. The results should lead to better and more uniform medicinal products. Drug cultivation is doing for medicinal plants, what plant breeding has done for other economic forms of vegetation. Years of patient efforts have been necessary to raise them from wild forms to their present high state of development. When medicinal plants have been cultivated and improved to this extent, a new strain of belladonna or henbane will be no more impossible than a new rose or garden vegetable.

Our research department has conducted many experiments along the lines of drug improvement and has demonstrated that medicinal plants may be made to yield according to the methods of economic plant breeding used. Atropa belladonna var. lutea was unknown in this country until successfully propagated and grown in our gardens in 1912. It has received little mention in literature though it uniformly contains a higher percentage of alkaloids than Atropa belladonna. Another instance that well illustrates the point is that of cannabis indica. Several years of careful growing and selection were necessary in order to isolate a strain which when grown within the United States would compare favorably with the imported drug. This has been accomplished and our own fields now yield a domestic product equal to the foreign drug. All available species of digitalis as well as the numerous garden varieties have been grown and tested and only one has been found which surpasses the official purpurea species in terms of toxicity. Hybrids between purpurea and ambigua have been produced and are still to be seen among our experiments, but they have shown no improvement over the standard. This fact only indicates that the breeding of medicinal plants does not differ in essentials from the breeding of other forms of plant life. Thousands of worthless hybrids have been produced to obtain one of commercial value.

Much impatience has been manifest in the work of drug cultivation, the majority of prospective growers failing to consider the fact that they are working with wild plants, which do not as a rule respond readily to standard agricultural methods. Growers also, fail to appreciate the care necessary to the successful harvesting and curing of a crop of medicinal plants. Recent investigations have done much to emphasize this and the future will probably reveal many vital facts concerning the phyto-chemic changes involved

during the collecting and curing of the various plant parts used in medicine. Probably no group of plants useful to man has been so little investigated in this respect as those yielding the vegetable drugs. We smoke tobacco grown almost according to formula but accept our medicine as nature sees fit to present it, collected and cured for the most part by the hands of ignorant peasantry.

More exact methods of collection and preparation are associated closely with the problems of cultivation. Uniformity of growth and character of plant are best obtained under artificial conditions of growth and facilitate collection and curing. A uniform product may then become a possibility, while it is a rare occurrence in drugs from the wild or natural source. The various parts of plants used under existing standards are subject to change with further investigations. It has been found that digitalis leaves need no longer be collected from the flowering plant, the leaves from the plant prior to the flowering period being fully as potent. Certain portions of the stems of belladonna are now admitted and our investigations have shown a higher percentage of alkaloids in portions of stramonium stems than in the leaves themselves. There has been continued controversy as to the part of the plant that should be allowed in cannabis, with the result that practically everything has been excluded except the female inflorescence. Leaves and stems as well as the whole of the male plants have been found to be practically inert. The storing of this drug must also be carefully controlled and the time from harvesting to finished product must not extend over a few months unless the drug is carefully packed in alcohol. These facts in addition to many others can only be demonstrated by careful investigations extending over long periods of time and are all vital factors to successful drug growing. The fact that these phases of drug cultivation are the subject of careful research indicates the change noted in the character of the work now being conducted along the lines of medicinal plant growing.

The internal conditions of the warring nations supplied an active stimulus to drug growers. Practically all of our most essential drugs were supplied by these countries. The sources of supply being eliminated made it necessary for growers to expand their experimental operations to a commercial scale. The results have been such that supplies were insured, and of greater importance still, quality has not declined. This has been mainly due to previous attempts toward cultivation and improvement. Our belladonna, cannabis, valerian and stramonium fields have furnished us a constant and uniform supply of drug of excellent quality not equalled

by that from former sources. The movement need only be continued along the lines indicated to prove that drug growing will become an essential part of the pharmaceutical industry.

Cooperation is lending much to the advancement of this movement. Other nations have felt the shortage of vegetable drugs and have not been slow to advocate their systematic production. Interchange of ideas in the form of published bulletins has simplified many problems and the exchange of reliable seeds has hastened results.

PHARMACEUTIC PREPARATIONS

Pharmaceutic preparations are those preparations made by pharmacists, the formula and directions being given for their preparation in the United States Pharmacopeia and National Formulary; and nearly one-half of the articles of the U.S.P. and all in the N.F. are *pharmaceutic.*

The pharmaceutic preparations of the U.S.P. may be classified as follows:

I. The solutions.
II. The mixtures.
III. Products by extraction.
IV. Mixtures of solids.
V. Preparations for external use.

These groups are subdivided into a number of classes, each class having a distinct Latin title which officially designates its members, or individual preparations, and by which they are alphabetically arranged in the U.S.P. Besides the Latin and English titles, each class is also known by an English name and various synonyms. In both the U.S.P. IX and X the synonyms and official abbreviations are given. The student will gradually become acquainted with the various classes and names of each by carefully studying the following classification:

I. THE SOLUTIONS

The general class of pharmaceutic preparations called "The Solutions" includes nine subclasses, each classified according to the solvent used:

1. Aromatic Waters.—Aquæ Aromaticæ.—Aromatic waters are solutions of *volatile* substances in water. They embrace the popular aqueous solutions of the volatile oils, and in these cases are made by first triturating the oil with some insoluble substance, as talc, precipitated calcium phosphate, or magnesium carbonate, thus dividing

the globules of the oil and distributing it over much surface, after which distilled water, recently boiled, is added, when, by filtering, the water abstracts from the mixture all of the oil that it is capable of holding in solution. These aromatic waters were formerly known as "medicated waters" and are popular in dental practice. Unless otherwise directed, they should be made by the following general process:

GENERAL PROCESS, U.S.P. IX

Volatile Oil, *two cubic centimeters*...(2 cc.—30 m.).
Purified Talc, *fifteen grammes*.....(15.0 Gm.—3.9 dr.).
Distilled Water, recently boiled, *one thousand cubic centimeters* (1,000 cc.–1 qt.).

Triturate the volatile oil with the purified talc, add the recently boiled distilled water gradually with continued trituration, filter, and pass the filtrate through the filter repeatedly until the Aromatic Water is perfectly clear.

The U.S.P. X directs that Aromatic Waters may be prepared by (a) *Distillation* where the water is distilled from the aromatic drug, and by (b) *Solution* where the volatile substance is shaken with the required amount of water (1,000 cc.) in a capacious bottle. In the opinion of the author it will be found more convenient in making Aromatic Waters in the dental office to follow the "general process" of the U.S.P. IX.

The waters most commonly used are:

Ammonia Water (Aqua Ammoniæ).
Camphor Water (Aqua Comphoræ).
Cinnamon Water (Aqua Cinnamomi).
Distilled Water (Aqua Destillata).
Sterilized Distilled Water (Aqua Destillata Sterilisata).
Hamamelis (witch-hazel) Water (Aqua Hamamelidis) (Nonofficial).
Peppermint Water (Aqua Menthæ Piperitæ).
Rose Water (Aqua Rosæ).

2. Solutions.—Liquores.—These preparations are solutions of *non-volatile* substances in water. The official solutions contain only inorganic salts.

The most important solutions are:

Antiseptic Solution, Mouth-wash (Liquor Antiseptici, N.F.).
Alkaline Antiseptic Solution, Mouth-wash (Liquor Antiseptici Alkalini, N F.).
Solution of Calcium Hydroxid, Lime-water (Liquor Calcii Hydroxidi).
Compound Solution of Cresol (Liquor Cresolis Compositus).

Compound Solution of Chlorin (Liquor Chlori Compositus) (Nonofficial).
Solution of Epinephrenin Hydrochlorid (Liquor Epinephreninæ Hydrochloridi).
Solution of Ferric Subsulphate, Monsel's Solution (Liquor Ferri Subsulphatis) (Nonofficial).
Solution of Formaldehyd, Formalin (Liquor Formaldehydi).
Solution of Hydrogen Dioxid (Liquor Hydrogenii Dioxidi).
Compound Solution of Iodin, Lugol's Solution (Liquor Iodi Compositus).
Solution of Magnesium Citrate (Liquor Magnesii Citratis).
Solution of Pituitary (Liquor Pituitarii).
Solution of Potassium Hydroxid (Liquor Potassii Hydroxidi).
Solution of Chlorinated Soda, Labarraque's Solution (Liquor Sodæ Chlorinatæ).
Surgical Solution of Chlorinated Soda, Modified Daken's Solution (Liquor Sodæ Chlorinatæ Chirurgicalis).
Physiologic Solution of Sodium Chlorid, Physiologic Salt Solution, Normal Saline Solution (Liquor Sodii Chloridi Physiologicus).
Solution of Sodium Hydroxid (Liquor Sodii Hydroxidi).
Solution of Zinc Chlorid (Liquor Zinci Chloridi).

3. Spirits.—Spiritus.—The spirits are solutions of *volatile* substances in alcohol. Several of the official spirits are solutions of essential oils, and are frequently called "Aromatic Spirits" or "Essences."

The most important spirits are:

Spirit of Ammonia (Spiritus Ammoniæ) (Nonofficial).
Aromatic Spirit of Ammonia (Spiritus Ammoniæ Aromaticus).
Brandy (Spiritus Vini Vitis).
Spirit of Camphor (Spiritus Camphoræ).
Spirit of Cinnamon (Spiritus Cinnamomi).
Compound Spirits of Ether, Hoffmann's Anodyne (Spiritus Ætheris Compositus) (Nonofficial).
Compound Spirit of Juniper (Spiritus Juniperi Compositus) (Nonofficial).
Spirit of Myrcia, Bay-rum (Spiritus Myrciæ) (Nonofficial).
Spirit of Nitroglycerin, Spirit of Glonoin (Spiritus Glycerylis Nitratis).
Spirit of Peppermint (Spiritus Menthæ Piperitæ).
Whisky (Spiritus Frumenti).

4. Syrups.—Syrupi.—Syrups are nearly *saturated* solutions of *sugar* in *water*, in which medicinal or flavoring agents are dissolved. The most important syrups are:

Simple Syrup (Syrupus) (85 per cent. Sugar).
Syrup of Acacia (Syrupus Acaciæ) (Nonofficial).

Syrup of Calcium Lactophosphate (Syrupus Calcii Lactophosphatis) (Nonofficial).
Syrup of Wild Cherry (Syrupus Pruni Virginianæ).
Syrup of Ginger (Syrupus Zingiberis).
Syrup of Hypophosphites (Syrupus Hypophosphitum) (Nonofficial).
Syrup of Ipecac (Syrupus Ipecacuanhæ).
Syrup of Iron, Quinin and Strychnin Phosphates (Syrupus Ferri, Quininæ et Strychninæ Phosphatum (Nonofficial).
Syrup of Orange (Syrupus Aurantii).
Syrup of Pine Tar (Syrupus Piscis Pini).
Compound Syrup of Sarsaparilla (Syrupus Sarsaparillæ Compositus).
Compound Syrup of Squill, Hive Syrup (Syrupus Scillæ Compositus).
Syrup of Senna (Syrupus Sennæ).
Syrup of Tolu (Syrupus Tolu).
Syrup of Wild Cherry (Syrupus Pruni Virginianæ).

5. Honeys.—Mellita.—Honeys are solutions of certain substances in clarified honey. Honey of rose (mel rosæ) is an example.

6. Elixirs.—Elixiria.—Elixirs are solutions containing aromatic substances, sugar, alcohol, and water. They are used largely to mask the taste of nauseating drugs. There are only two official elixirs:

Aromatic Elixir, Simple Elixir (Elixir Aromaticum).
Elixir of Glycyrrhiza, Elixir of Licorice (Elixir Glycyrrhizæ).
Elixir of Iron, Quinin and Strychnin Phosphates (Elixir Ferri, Quininæ et Strychninæ Phosphatum) (Nonofficial).

7. Glycerites.—Glycerita.—Glycerites are solutions of *medicinal substances* in glycerin. The most important glycerites are:

Glycerite of Boroglycerin (Glyceritum Boroglycerini).
Glycerite of Iron, Quinin and Strychnin Phosphates (Glyceritum Ferri, Quininæ et Strychninæ Phosphatum) (Nonofficial).
Glycerite of Phenol, Glycerite of Carbolic Acid (Glyceritum Phenolis).
Glycerite of Starch (Glyceritum Amyli).
Glycerite of Tannic Acid (Glyceritum Acidi Tannici).

8. Oleates.—Oleata.—Oleates are solutions of *metallic oxids* or *alkaloids* in oleic acid. The useful oleates are:

Oleate of Cocain (Oleatum Cocainæ) (Nonofficial).
Oleate of Mercury (Oleatum Hydrargyri).

9. Collodions.—Collodia.—Collodions are solutions of *medicinal substances* in collodion, *i.e.*, gun-cotton (pyroxylin) dissolved in ether

and alcohol. These preparations are used externally, and chiefly as protectants. The important collodions are:

Collodion (Collodium).
Cantharidal Collodion, Blistering Collodion (Collodium Cantharidatum) (Nonofficial).
Flexile Collodion (Collodium Flexile).
Styptic Collodion (20 per cent. Tannic Acid) (Collodium Stypticum) (Nonofficial).

II. THE MIXTURES

This general class of pharmaceutic preparations includes such liquid preparations as are not clear solutions, or solutions that cannot be classified according to the solvent used. There are three subclasses:

1. Mixtures.—Misturæ.—Mixtures are liquid preparations usually holding in suspension in water some insoluble substance. Mixtures should be well shaken before being administered. Examples of official mixtures are:

Chalk Mixture (Mistura Cretæ).
Compound Mixture of Glycyrrhiza, Brown Mixture (Mistura Glycyrrhizæ Composita).

2. Emulsions.—Emulsa.—Emulsions are liquid preparations consisting of oily, fatty, resinous, or otherwise *insoluble* substances, suspended in water by the aid of some gum or mucilage called the *emulsifying agent,* as acacia or tragacanth. Milk and the yolk of egg are natural emulsions. The important official emulsions are:

Emulsion of Cod-liver Oil (Emulsum Olei Morrhuæ).
Emulsion of Oil of Turpentine (Emulsum Olei Terebinthinæ).

3. Liniments.—Linimenta.—These are liquid preparations for external use, consisting of solutions of *oily* or *resinous* constituents in alcohol or oils, or mixtures of liquid soaps. With the exception of belladonna liniment and lime liniment, which are used as sedative applications, all the official liniments are of a stimulating character, and should be applied with friction or massage. The useful official liniments are:

Belladonna Liniment (Linimentum Belladonnæ).
Camphor Liniment (Linimentum Camphoræ).
Dental Liniment (Linimentum Dentalis) (Nonofficial).
Lime Liniment, Carron Oil (Linimentum Calcis).
Liniment of Soft Soap, Tincture of Green Soap (Linimentum Saponis Mollis).

III. PRODUCTS BY EXTRACTION[1]

The medicinal constituents, called *active principles*, of crude drugs are obtained by extraction. The liquid used is termed the *menstruum*, and may be water or alcohol or both in varying proportions, with sometimes the addition of glycerin. This general class is represented by nine subclasses.

1. Mucilages.—Mucilagines.—These are solutions of gums or other mucilaginous constituents of vegetable drugs extracted with an aqueous menstruum. They are used as emollients, as emulsifying agents for suspending insoluble substances in liquids, and as excipients for pills.

The important mucilages are:

Mucilage of Acacia (Mucilago Acaciæ).
Mucilage of Sassafras Pith (Mucilago Sassafras Medullæ) (Nonofficial).
Mucilage of Tragacanth (Mucilago Tragacanthæ).
Mucilage of Elm (Mucilago Ulmi) (Nonofficial).

2. Infusions.—Infusa.—Infusions are liquid preparations made by pouring boiling water on vegetable drugs in a suitable vessel provided with a cover, allowing it to stand for half an hour, and then straining. Tea, if properly made, is an infusion. There is only one official infusion:

Infusion of Digitalis (Infusum Digitalis).
Compound Infusion of Senna, Black Draught (Infusum Sennæ Compositum) (Nonofficial).

3. Decoctions.—Decocta.—Decoctions are liquid preparations made by pouring boiling water on vegetable drugs in a suitable vessel provided with a cover, allowing it to boil for fifteen minutes, and then, when sufficiently cooled, strain. Coffee, as usually made, is a decoction. There are no official decoctions.

4. Vinegars.—Aceta.—Vinegars are liquid preparations made by treating vegetable drugs with dilute acetic acid. They are not much used in dentistry. Only one is official:

Vinegar of Squills (Acetum Scillæ).

5. Tinctures.—Tinctura.—These are alcoholic or hydroalcoholic solutions of the soluble constituents of crude drugs or of non-volatile

[1] The U.S.P. formerly recognized a class of preparations known as "Wines" under "Products by Extraction." This class was dropped in the U.S.P. IX. It is there stated that wine as a menstruum or solvent can with advantage be replaced by alcohol of various strengths, and the uncertainties due to the variability in quality and alcoholic content of the wines of commerce are avoided. Wines, therefore, will not be discussed here.

substances (except iodin). Tinctures are the simplest form of alcoholic products by extraction, and as a class have no uniform strength. Tinctures of potent drugs are made of the strength of *ten grammes* of drug in *one hundred cc.* of tincture. The other tinctures vary in the proportion of drug in the finished product, but many of these are made of the strength of *twenty grammes* of drug to *one hundred cubic centimeters* of tincture. Where it has been found possible and desirable to standardize the tinctures, an assay is required by the U.S.P. This is true of *tincture of opium*, *tincture of deodorized opium* U.S.P. IX, and *tincture of nux vomica*. From a tincture all the other preparations may be *progressively* produced through concentration by evaporating the menstruum, as follows:

Fluid extract representing a uniform drug-strength, viz.: 1 troy ounce in 1 fluidounce (1 gram in 1 cc.).

Extract, or "solid extract," a semi-solid mass of pilular consistence of no uniform drug strength, or assayed and powdered with diluent, to represent a certain alkaloidal strength (opium and nux vomica).

Abstract, or "powdered extract," by incorporating sugar of milk with the extract to represent one-half the weight, or twice the strength of the drug.

Resins, separation of the resinous constituents, by precipitation in water of a concentrated alcoholic tincture.

Tinctures are applied locally or administered internally by dentists more than any other subclass of pharmaceutic preparations. The following tinctures are among the most important:

Tincture of Aconite (Tinctura Aconiti).
Tincture of Belladonna Leaves (Tinctura Belladonnæ).
Tinctura Benzoin (Tinctura Benzoini).
Compound Tincture of Benzoin (Tinctura Benzoini Composita).
Tincture of Cannabis (Tinctura Cannabis) (Nonofficial).
Tincture of Cantharides (Tinctura Cantharidis).
Tincture of Capsicum (Tinctura Capsici).
Tincture of Calendula (Tinctura Calendulæ) (Nonofficial).
Tincture of Cinchona (Tinctura Cinchonæ).
Compound Tincture of Cinchona, Huxham's Tincture (Tinctura Cinchonæ Composita).
Tincture of Cinnamon (Tinctura Cinnamomi) (Nonofficial).
Tincture of Digitalis (Tinctura Digitalis).
Tincture of Ferric Chlorid (Tinctura Ferri Chloridi).
Tincture of Gelsemium (Tinctura Gelsemii) (Nonofficial).
Compound Tincture of Gentian (Tinctura Gentianæ Composita).
Tincture of Ginger (Tincturæ Zingiberis).

Tincture of Hyoscyamus (Tinctura Hyoscyami).
Tincture of Hydrastis, Tincture of Golden Seal (Tinctura Hydrastis) (Nonofficial).
Tincture of Iodin (Tinctura Iodi).
Tincture of Kino (Tinctura Kino).
Tincture of Myrrh (Tinctura Myrrhæ).
Tincture of Nux Vomica (Tinctura Nucis Vomicæ).
Tincture of Opium, Laudanum (Tinctura Opii).
Camphorated Tincture of Opium, Paregoric (Tinctura Opii Camphorata).
Tincture of Deodorized Opium (Tinctura Opii Deodorati).
Tincture of Rhubarb (Tinctura Rhei).
Ammoniated Tincture of Valerian (Tinctura Valerianæ Ammoniata).

6. Fluid Extracts.—Fluidextracta.—These are concentrated tinctures of such strength as to closely represent the drug *volume for weight*, *i.e.*, one fluidounce closely represents the useful constituents of one troy ounce of the air-dried and powdered drug of standard quality (1 cc. = 1 gram).

The preparations in this class are prescribed largely by physicians, for they possess the advantage of having a uniform strength. The fluid extracts of the U.S.P. X, with few exceptions, may be classified according to the menstruum used in the extraction of the drug and the process of manufacture employed. The best pharmaceutic houses today standardize their fluid extracts. These preparations are not employed by dentists, however, as much as are the tinctures. The most important fluid extracts are:

Fluid Extract of Belladonna Leaves (Fluidextractum Belladonnæ Foliorum).
Fluid Extract of Belladonna Root (Fluidextractum Belladonnæ Radicis).
Fluid Extract of Cannabis (Fluidextractum Cannabis).
Aromatic Fluid Extract of Cascara Sagrada (Fluidextractum Cascaræ Sagradæ Aromaticum).
Fluid Extract of Cinchona (Fluidextractum Cinchonæ).
Fluid Extract of Ergot (Fluidextractum Ergotæ).
Fluid Extract of Eucalyptus (Fluidextractum Eucalypti).
Fluid Extract of Hydrastis (Fluidextractum Hydrastis).
Fluid Extract of Hyoscyamus (Fluidextractum Hyoscyami).
Fluid Extract of Ipecac (Fluidextractum Ipecacuanhæ).
Fluid Extract of Senna (Fluidextractum Sennæ).

7. Extracts.—Extracta.—These are *soluble active principles* of vegetable drugs concentrated by evaporation to a soft solid. They are called "solid" or "pilular" extracts to distinguish them from fluid extracts. They preserve the useful constituents of the drug in a

concentrated, relatively uniform and permanent condition, and in a form suitable for medication. When employed, they are usually dispensed in pills or capsules. The *extract of opium* and *extract of nux vomica* are required to be assayed, as are other extracts of potent drugs where it has been found possible and desirable to standardize them. The important extracts are:

Extract of Belladonna (Extractum Belladonnæ).
Extract of Cascara Sagrada (Extractum Cascaræ Sagradæ).
Extract of Cannabis (Extractum Cannabis).
Extract of Ergot (Extractum Ergotæ) (Nonofficial).
Extract of Hyoscyamus (Extractum Hyoscyami).
Extract of Malt (Extractum Malti).
Extract of Nux Vomica (Extractum Nucis Vomicæ).
Extract of Rhubarb (Extractum Rhei).

Abstracts.—Abstracta.—These are a class of powdered extracts formerly recognized by the U.S.P. (1880), prepared from the extracts by the addition of sufficient sugar of milk to make the product represent one-half *its weight* of the crude drug. The abstracts have a uniform relation to the drug in that *one grain represents two grains of the drug*, just as the fluid extracts have the uniform relation of representing the drug *volume* for *weight.* There are no official abstracts. An ideal abstract can be made from tincture of valerian, as the volatile oil in valerian does not permit of the evaporation necessary for an extract. Abstract of valerian is one of the most practical preparations of the drug.

8. Oleoresins.—Oleoresinæ.—There are *natural* and *pharmaceutic* oleoresins. The natural oleoresins have been elsewhere considered. The pharmaceutic oleoresins are semi-liquid extracts, obtained by exhausting oleoresinous drugs with ether. The ether extracts *fixed* and *volatile oils* from drugs, as well as *resins.* Oleoresins are not used in dentistry to any extent, but have been briefly considered here in order to make our classification complete. An example of an official oleoresin is:

Oleoresin of Capsicum (Oleoresina Capsici).

9. Resins.—Resinæ.—Resins have previously been considered under the constituents of drugs. The official resins may be divided into the (1) natural resins, (2) resins obtained from oleoresins by separating the volatile oil by distillation, and (3) pharmaceutic resins, prepared by *precipitation.* Important official resins are:

Resin, Rosin, Colophony (Resina).
Resin of Jalap (Resina Jalapæ).
Resin of Podophyllum, May Apple (Resina Podophylli).

IV. MIXTURES OF SOLIDS

The general class called *mixtures* of *solids* includes several subclasses of pharmaceutic preparations for internal use:

1. Powders.—Pulveres.—These are impalpable mixtures of one or more active drugs, usually with some nearly inert substance, as sugar and aromatics. The nearly inert substance used to give bulk to official powders is called the *diluent*. The important powders are:

Compound Acetanilid Powder (Pulvis Acetanilidi Compositus) (Nonofficial).
Compound Chalk Powder (Pulvis Cretæ Compositus).
Compound Effervescing Powder, Seidlitz Powder (Pulvis Effervescens Compositus).
Powder of Ipecac and Opium, Dover's Powder (Pulvis Ipecacuanhæ et Opii).

2. Effervescent Salts.—Sales Effervescentes.—These are granulated mixtures of salts with sugar, sodium bicarbonate and organic acids (tartaric and citric), which effervesce when the mixture is added to water and furnish agreeable aerated draughts. They were new additions to the U.S. P. VIII, but as a class are dropped in the U.S.P. IX and X. They are highly useful in dentistry, and the following examples are here given:

Effervescent Caffein Citrate (Caffeina Citrata Effervescens) (Nonofficial).
Effervescent Lithium Citrate (Lithi Citrata Effervescens) (Nonofficial).
Effervescent Magnesium Sulphate (Magnesii Sulphas Effervescens) (Nonofficial).
Effervescent Potassium Citrate (Potassii Citrata Effervescens).
Effervescent Sodium Phosphate (Sodii Phosphas Effervescens).

3. Confections.—Confectiones.—These are *flavored masses* wherein the adhesive substance is sugar and water, or honey, serving as a *vehicle* to mask the taste of the drug. None are official in the U.S.P. X. Examples are:

Confection of Rose (Confectio Rosæ) (Nonofficial).
Confection of Senna (Confectio Sennæ) (Nonofficial).

4. Troches or Lozenges.—Trochisci.—These are confections made in various forms and dried. Most of the troches are intended

to influence the mucous membrane of the mouth and throat, and are useful preparations. The most important are:

Troches of Tannic Acid (Trochisci Acidi Tannici).
Troches of Ammonium Chlorid (Trochisci Ammonii Chloridi).
Troches of Potassium Chlorate (Trochisci Potassi Chloratis) (Nonofficial).
Troches of Sodium Bicarbonate (Trochisci Sodii Bicarbonatis) (Nonofficial).

5. Masses.—Massæ.—These are plastic mixtures preserved in bulk and intended for forming into pills. There are two official:

Mass of Ferrous Carbonate, Vallet's Mass (Massa Ferri Carbonatis).
Mass of Mercury, Blue Mass (Massa Hydrargyri).

6. Pills.—Pilulæ.—These are spherical, more or less soluble masses of medicinal substances rendered *cohesive, plastic,* and *firm* in consistence by the addition of some substance (usually inert), called *excipient.* The *kind* of excipient used varies with the nature of the medicinal substance. The various excipients employed are water, alcohol, glycerin, syrups, glucose, glycerite of starch, mucilage of tragacanth, etc.

The following pills are important:

Pills of Aloes (Pilulæ Aloes).
Compound Cathartic Pills (Pilulæ Catharticæ Compositæ).
Pills of Ferrous Carbonate, Blaud's Pills (Pilulæ Ferri Carbonatis).
Pills of Phosphorus (Pilulæ Phosphori).

7. Tablets.—Tabellæ.—These are small disks containing medicinal substances mixed with sugar and mucilage. They are a convenient form in which to administer potent remedies, such as the alkaloids, calomel, etc. Blank tablets, *i.e.*, those containing no medicinal substance, can be obtained and serve as a pleasant means of administering concentrated liquid preparations, such as the fluid extracts, by dropping from two to five minims of the preparation on the tablet. The U.S.P. IX recognized only one tablet. This is true also of the U.S.P. X, *and this is not for internal use.* It is here given:

Poison Tablets of Corrosive Mercuric Chlorid, Corrosive Sublimate Tablets, Bichlorid Tablets (Toxitabellæ Hydrargyri Chloridi Corrosivi).

These tablets are of an angular shape (not discoid), each having the word "POISON" and the skull and cross bones design dis-

tinctly stamped upon it. The tablets are to be colored blue, and each must contain a specified amount of corrosive mercuric chlorid.

V. PREPARATIONS FOR EXTERNAL USE

This class of pharmaceutic preparations includes such products as are used for external medication. Liniments, oleates, and collodions are employed externally, but being *true solutions* are classified as such. The classification of the groups here considered is based upon the *fusibility*, or melting-point, of the preparations, which is governed by the respective *vehicles* employed.

1. Ointments.—Unguenta.—These are mixtures wherein medicinal substances are incorporated in a fatty vehicle. The *vehicles* used are: Benzolated lard, lard and wax or spermaceti in varying proportions, lard oil, olive oil and suet. Petrolatum and lanolin (wool-fat) are largely used in nonofficial ointments. The following are important official ointments:

Ointment of Boric Acid (Unguentum Acidi Borici).
Ointment of Tannic Acid (Unguentum Acidi Tannici).
Ointment of Rose Water, Cold Cream (Unguentum Aquæ Rosæ).
Ointment Ammoniated Mercury (Ungentum Hydrargyri Ammoniati).
Stronger Mercurial Ointment (Unguentum Hydrargyri Fortius).
Mild Mercurial Ointment (Ungentum Hydrargyri Mite).
Ointment of Yellow Mercuric Oxid (Unguentum Hydrargyri Oxidi Flavi).
Iodin Ointment (Unguentum Iodi).
Iodoform Ointment (Unguentum Iodoformi).
Ointment of Phenol, Ointment of Carbolic Acid (Unguentum Phenolis).
Ointment of Zinc Oxid (Unguentum Zinci Oxidi).

Nonofficial ointments in use are:

Ointment of Arsenic Trioxid, Devitalizing Paste (Unguentum Arseni Trioxidi).
Ointment of Camphor (Unguentum Camphoræ, N.F.).
Ointment of Europhen and Orthoform, Euroform Paste (Unguentum Europheni et Orthoformi).
Ointment of Paraformaldehyd and Neothesin, Desensitizing Paste (Unguentum Paraformaldehydi et Neothesini).

2. Cerates.—Cereata.—These are mixtures of medicated fats similar to ointments, but of firmer consistence because they contain

wax, resin, or paraffin which raises the melting-point. The important official cereates are:

Simple Cereate (Cereatum).
Cantharides Cereate, Blistering Cereate (Cereatum Cantharidis).

Important nonofficial cereates are:

Compound Cereate of Camphor, Camphor Ice (Cereatum Camphoræ Compositum, N.F.).
Cereate of Bismuth Subnitrate, Beck's Cereate (Cereatum Bismuthi Subnitras).

3. Suppositories.—Suppositoria.—These are variously shaped masses of medicated fats, intended to be inserted into the orifices of the body, as the rectum, vagina, urethra, or nostril. The usual vehicle is oil of theobroma (cacao butter). Suppositories are expected to melt at body temperature. The only official one is:

Suppositories of Glycerin (Suppositoria Glycerini).

4. Plasters.—Emplastra.—Mixtures of solids having a fatty or resinous vehicle, and of such high melting-point as to be friable when cold, but rendered *adhesive* by the warmth of the body.

The *vehicles* of plasters are: Lead plaster; resinous substances, made adhesive by admixture with the medicinal ingredients, and simple plasters, such as isinglass. Important official plasters are:

Belladonna Plaster (Emplastrum Belladonnæ).
Capsicum Plaster (Emplastrum Capsici).
Rubber Plaster, Rubber Adhesive Plaster (Emplastrum Elasticum).
Mustard Plaster, Mustard Paper (Emplastrum Sinapis).

A nonofficial plaster is:

Isinglass Plaster, Court Plaster (Emplastrum Ichthyocollæ).

5. Papers.—Chartæ.—These are strips of unsized, white paper saturated or coated with some medicinal substance. They are intended to be moistened and applied as a plaster, or else to be burned and the fumes inhaled. The only one official in the U.S.P. VIII was Mustard Paper (Charta Sinapis). This is now recognized as a plaster proper, as mentioned above.

6. Poultices.—Cataplasmata.—These are semi-liquid preparations made by mixing such coarsely ground substances as flaxseed, elm-bark, or bread, with hot water or milk. They are spread upon cloth or poured into porous bags, and used for applying heat and moisture to the tissues, or for securing a local stimulant effect.

Charcoal is sometimes added as an absorbent and mustard as a stimulant. There are none official. The U.S.P. VIII recognized the following:

Cataplasm of Kaolin (Cataplasma Kaolini).

7. Fomentations.—Fomenti.—These are porous woolen cloths saturated with hot infusion or decoction of herbs, or other hot liquids or lotions (saturated solution of boric acid), and applied hot. Thev are useful preparations, but none official.

8. Absorbent Cotton.—Gossypium Purificatum.—The hairs of the seed of cotton, freed from oil and resinous substances by treatment with alkalies and bleaching agents. These hairs represent microscopic ducts through which liquids are absorbed by capillary attraction. The absorbability of cotton, then, depends upon its purity, or the freedom from oily and resinous substances. This is equally true of all other material used for bandages.

MISCELLANEOUS LIST OF NONOFFICIAL BANDAGES, SPLINTS, MEDICATED AND ANTISEPTIC DRESSINGS, AND MEDICATED GAUZES

Bandages.—These are mechanical supports, serving also to keep wounds clean by absorbing and withdrawing such secretions as would otherwise prove irritating, and by protecting the wound from extraneous matter, thus promoting the process of healing.

Plaster-of-Paris Bandages.—These are made by thoroughly incorporating a good quality of plaster-of-Paris (calcium sulphate) into linen bandages. After the bandage is adjusted, water is applied, when it sets in a few minutes.

Splints.—These are mechanical supports made from wood, metals (gold, platinum, lead, German silver, etc.), and vulcanite rubber. They serve the purpose of holding in proper position or alignment fractured bones and loosened teeth. The metallic splints are especially useful in orthodontia, pyorrheal treatment and the reduction of fractures of the mandible.

Medicated and Antiseptic Dressings.—These are made by saturating such materials as cotton, silk, wool, or asbestos fiber in a certain strength solution of the medicinal agent, or by incorporating the latter in powdered form. The fabric, which conveys the agent, simply serves as a vehicle for the medicinal or antiseptic drug. This means is largely employed in the application of medicines to the canals of teeth.

Medicated Gauzes.—The material used in making medicated gauzes is pure muslin gauze, which is thoroughly saturated with a certain strength solution of the medicinal substance desired, then forcibly expressed, after which it is ready for use. Medicated gauzes should be kept in tightly covered boxes or jars in a cool, dry place. They are largely used for packing and medicating wounds. The following gauzes are in common use:

Borated Gauze.	Iodoform Gauze.
Phenolized Gauze.	Euroform Gauze.

METHODS OF ADMINISTERING OR APPLYING DRUGS

The physiologic and therapeutic effect of remedies is often largely determined by the methods in which they are administered or applied; and it is a well-established principle that the nearer the remedy is applied to the site of the disease the more effectual and safer is its use. Recognizing this principle, remedies should be applied locally as far as possible. There are many pathologic conditions, however, confronting the dentist which cannot be reached and acted upon favorably by the local application of medicines. It is, therefore, the plain duty of every practitioner of dentistry to so familiarize himself with drugs and their internal administration that he will be able to treat successfully any case which arises in his practice.

By the Mouth.—This is the original and most common method employed for the administration of the great majority of medicines. Drugs are given by the mouth for their local action on the mucous membrane and deeper seated tissues of the mouth, throat, stomach, or intestines, or for the purpose of being absorbed. The absorption of drugs may take place from any part of the alimentary canal. Some powerful remedies are readily absorbed from the tongue. A dose of spirit of nitroglycerin, placed under the tongue, will produce its physiologic effect in from three to five minutes. Remedies intended to influence the mouth or throat are often given in the form of a troche or lozenge. When absorption of the remedy from the stomach is desired, it should be administered in solution or in such condition as to be acted upon by the gastric secretions and made soluble. The reaction of the gastric juice is acid, while the intestinal juices are alkaline. Any substance, therefore, soluble in either an acid or alkaline medium, is acted upon favorably by the secretions of the stomach or intestines. Such remedies as calomel, salol, and salophen, requiring an alkaline liquid for their solution, pass through the stomach practically unchanged, and are digested and absorbed almost entirely in the intestines. The general rule for

administering remedies intended to be absorbed in the stomach is to give them on an empty stomach, that is, half an hour or an hour before meals. This rule should not be followed, however, in the case of remedies having a local irritant action, as potassium bromid or potassium iodid, etc. It is far better to give these remedies well diluted in water, and immediately after meals, so that their local effect is more or less avoided by their admixture with the food.

Hypodermic.—This method consists in injecting solutions of medicinal substances into the submucous and subcutaneous tissues by means of the hypodermic needle and syringe, and is largely employed in dental practice. The method has many advantages, such as the great rapidity with which absorption is effected, for local medication, and the certainty of securing the action of the entire dose. The alkaloidal salts, as cocain hydrochlorid, on account of their small bulk, are especially adapted for hypodermic use. The dose of a drug given hypodermically is generally about one-half that given by the mouth or stomach. There are several conditions wherein the hypodermic method of administering drugs is strongly indicated, viz.:

1. In conditions where the patient is unable to swallow, or where the stomach is unable to receive or retain medicines.

2. In conditions necessitating the immediate action of a drug or remedy, or where absolute certainty of the dose is desired.

3. In conditions where local medication is desired for the production of local anesthesia, for the relief of pain, as in neuralgia, or for stimulation of a deep-seated part.

The first two indications mentioned for this method of administering drugs are of interest to dentists in that the method is employed here in cases of emergency, as in collapse. The third indication is of prime importance, as it is employed every day in a busy practice for the purpose of injecting local anesthetics and other drugs for the mitigation of pain.

The factors to be remembered in using this method are:

1. Guard against septic infection.

2. Prevent the injection of air into a vein.

3. Prevent the injection of the medicine into a vein, unless in cases of emergency.

To *guard against septic infection*, it is necessary to have the hands and the field of operation as nearly sterile as they can be made and to have the hypodermic syringe, needle, and the solution absolutely sterile.

To *prevent injecting air into a vein*, it is essential that all of the air should be exhausted from the syringe before the injection is made. When the syringe is filled by drawing the solution into it, hold the point upward, tapping the side of the syringe gently to dislodge any air bubbles, then by pushing the piston until the solution escapes, the air is expelled. There is little danger of injecting air into a vein when the solution is injected into the submucous tissue of the mouth; nevertheless, it is well to avoid injecting air into the tissues, and when this method of drug administration is used other than in the mouth, the danger is correspondingly increased. If air enters a vein it is carried directly to the right side of the heart, where by the action of the tricuspid valve it forms a foam with the blood, resulting in *air-thrombosis*, which might cause death.

Occasionally in an emergency it is desired to *inject the medicine into a vein* that it may be at once carried to the heart; but ordinarily this should be avoided. To unintentionally inject the entire quantity into a vein might result in an overdose. By injecting slowly and holding the finger over the needle-point, one can readily guard against this danger. If the fluid accumulates, which should be easily detected by the finger, nothing need be feared; but if the fluid escapes readily and the accumulation cannot be detected, one may suspect that a vein has been punctured. In this case the needle should be slightly withdrawn and the injection continued.

The Hypodermic Syringe.—There are many varieties of hypodermic syringes on the market. It was difficult to thoroughly sterilize the old-style glass barrel and leather-covered piston syringe. During the past few years a great improvement has been made in both the glass barrel and all-metal syringes. The former has the advantage of permitting a view of the fluid or air within the barrel; the latter the advantage, if, indeed, it is an advantage, of being sterilized by boiling. It is no doubt true that the repeated boiling of a hypodermic syringe will soon cause it to leak and unfit it for use. It has also been found the safest and best practice to keep the syringes, needles, etc., when not in use, immersed in about a 70 per cent. solution of alcohol, to which 1 per cent. of thymol and about 5 per cent. of glycerin has been added. This may be done by having a suitable glass jar for the purpose. There are a variety of syringes and needles on the market. The operator should select and keep on hand the kinds which best meet his daily need.

Technic of the Injection.—The method of injecting medicines hypodermically differs somewhat with the site of application; therefore, it will be discussed under different headings:

1. Through the skin into the cellular tissue of the body.

2. Through the mucous membrane into the various submucous tissues, such as the gums, gingivæ and alveolar process.

3. Through the tooth structure into the pulp tissue.

In injecting drugs hypodermically *through the skin* it is essential to guard against the dangers incident to this method of administering medicine. The solution should be sterile to begin with, the syringe and needle may be sterilized as the operator deems best, the hands by washing with green soap and followed with an application of alcohol (60 to 70 per cent.), 1–1,000 solution of mercuric chlorid, or 1–500 solution of sublamin; the site of application may be sterilized in the same manner as the hands. Various solutions containing iodin are also popular for this purpose. · The selection of the site for making the injection depends upon the circumstances of the case. It may be made upon any accessible part of the body, usually, however, the arm or lumbar region of the back. After exhausting the air from the syringe, hold it firmly in the right hand, and with the left grasp the skin at the selected site. The needle should now be pushed quickly through the skin at nearly right angles to the surface, and should penetrate quite deeply. The injection should be made slowly, and with the forefinger of the left hand determine whether it is causing distention of tissue or escaping rapidly.

The dentist, as has been intimated, is particularly interested in the technic of injecting drugs hypodermically *through the mucous membrane* and into the various submucous tissues (both soft and hard) for the purpose of producing local anesthesia. In the past there seems to have been an inherent prejudice by many practitioners against the use of local anesthetics in dentistry. The author and many others have advocated their use for years. Cocain was the drug largely used. With the introduction and use of procain (novocain) a synthetic substitute for cocain, and a drug claimed to be far less toxic, this prejudice has gradually disappeared. The insistent demand for "painless dentistry" has made the use of local anesthetics and the hypodermic method of administering the same very popular in dental practice.

It is sufficient at this time for the student to learn that local anesthesia in the mouth is produced in three ways: *Infiltration*, *interosseous* and *conduction* (nerve blocking) *anesthesia*. In the infiltration method the local anesthetic solution is injected in the submucous tissues immediately around the part to be anesthetized, simply permitting the solution to *infiltrate* the tissues. The interosseous method consists of first making a small submucous injection

to anesthetize a small area of gum tissue when the latter and cortex of the bone are pierced with a suitable drill; through which opening a few minims of the solution are deposited slowly, permitting it to *diffuse through the spongiosa of the bone*, thus producing complete anesthesia of one or two teeth almost instantly. By conduction anesthesia or nerve blocking is meant the process of injecting local anesthetic solutions submucously into the tissues surrounding the foramen through which the nerve makes its entrance or exit; thus anesthetizing the nerve at this point, when the effect of which is *conducted* to the periphery, blocking the nerve as it were, and causing temporary loss of sensation in the part supplied by this nerve. Before anesthetizing any part or undertaking any surgical operation, the mouth should be rinsed, or, better, sprayed with an antiseptic solution. The solution, syringe, needle, hands of the operator, and field of operation should be sterilized as previously mentioned. We have considered here the principles of local anesthesia only; the detailed technic of making the various injections will be considered later as occasion requires.

The forcing of local anesthetic agents *through the tooth structure and into the pulp* is known as **pressure anesthesia** and is elsewhere considered.

Epidermic or Inunction.—This method consists in applying medicinal substances, dissolved in fatty vehicles, to the unbroken skin when absorption of the remedy is fairly well brought about, especially if friction be used in their application. Ointments are largely employed in this manner.

Intravenous.—This method is used in great emergency where it is desired to inject a stimulating or restorative agent directly into a vein. Physiologic salt solution (8.5 parts of sodium chlorid in 1,000 parts of sterile water—8.5 grams in 1,000 cc.) is the remedy mostly employed in this manner. The solution is intended to correspond to blood serum in salinity, and is given intravenously in cases of copious hemorrhage, or in collapse.

Cataphoresis.—This method consists in the introduction of drugs in molecular form into tooth structure or living tissue by means of the electric current. The positive-pole applicator is saturated with a concentrated solution of the drug and placed within a cavity in the tooth being treated, or directly over the part to be medicated, the negative pole being placed somewhere on the patient's body,—usually held in the hand by means of a moist sponge. This method, with cocain hydrochlorid as the drug, has been used to obtund sensitive dentin and to anesthetize the dental pulp for the purpose of its pain-

less removal. The method will, therefore, again be considered more in detail.

By the Rectum.—This method is employed for the administration of both medicines and food, whenever, on account of inability to swallow or persistent vomiting, the mouth or stomach route cannot be used. The process of making the rectal injection is known as **Enema.** Absorption through the rectum is not nearly so rapid as through the stomach, hence to accomplish the same result it generally requires twice the dose by the rectum that would be necessary by the mouth, and solution of the drug should be assured before it is administered, unless a local effect is intended. For local medication suppositories are largely employed.

Inhalation.—This method can only be employed for volatile drugs or finely atomized liquids. Volatile drugs are rapidly absorbed from the respiratory tract, and this method is largely used in dental practice for the administration of such drugs as nitrous oxid, chloroform, and ether, when the general analgesic or general anesthetic effect is desired. The stimulating effect of such drugs as ammonia and amyl nitrite is also produced by inhalation. When it is desired to influence directly the mucous membrane of the mouth and respiratory tract, medicated vapors and sprays are often employed.

CONDITIONS MODIFYING THE ACTION AND EFFECT OF DRUGS

There are many conditions or circumstances which influence and modify the action and effect of drugs, chief of which are the age of the patient, the sex, race, size, temperament, disease, temperature, habit and idiosyncrasy, the method, time of administration, preparation, and dose of the drug.

Habit.—The tissues of the body can be induced to tolerate many drugs by their continuous administration. This is particularly true of opium and cocain. It is not definitely known just how this condition is brought about, but it is believed to be largely due to a change in the tissues themselves whereby they are rendered less susceptible to the influence of the drug. There is a crying demand to-day for "painless dentistry," and most dental operations can be made practically painless by the judicious use of narcotic drugs, especially the local anesthetics. Therefore, a word of caution here regarding the danger of forming the drug-habit will not be out of place. This habit is far more common than is generally known. It is the duty of every dentist to employ such reasonable measures as will mitigate pain,

but he should constantly guard his patient, as well as himself, against the formation of the drug-habit. In order to prevent the miscellaneous and injudicious prescribing of such habit-forming drugs as opium and cocain, Congress in 1915 passed a law, known as the "Harrison Narcotic Act," which requires physicians, dentists, and veterinarians to keep a record of all drugs used which are included in the Act.

Idiosyncrasy.—This is a peculiar susceptibility or insusceptibility of one or more of the tissues of the body to the influence of certain drugs for which no explanation can be found. Less than ¼ of a grain of calomel has been known to induce salivation, causing an inflammation in the pericemental membrane and teeth sore to pressure. With some individuals the smallest dose of quinin will produce a diffuse erythematous rash. Many patients have an idiosyncrasy for cocain, the smallest amount causing all of the toxic symptoms characteristic of the drug. Other patients have what may be called a presupposed idiosyncrasy, for cases are on record where the patient had all the symptoms of cocain-poisoning when only distilled water had been hypodermically injected, the patient, however, thinking cocain had been used.

One form of idiosyncrasy consists in the failure of the individual to react to the ordinary dose of the drug, and this particular form is called **Tolerance.**

Cumulative Effect.—This is another phenomenon of drugs caused by their prolonged administration when sudden and oftentimes a severe effect is produced, owing to the accumulation of the drug in the tissues of the body. Cumulative action may occur along with tolerance.

Dosage or Posology.—Under this heading can be discussed most of the conditions which modify the effect of drugs not previously considered, for whatever modifies the effect of drugs must also necessarily influence dosage. In regard to dosage Butler[1] says: "Common sense ought long since to have told us that the doses prescribed in text-books are only based upon experience in certain cases, or upon experimentation made upon animals. From such data, however, the first author who wrote upon the posology of different substances started, and others have simply copied after the first. If any fact went beyond the well-defined limits, it was wont to be explained by the defective quality or method of preparation of the drug, or by an idiosyncrasy so rare that one would not even take the pains to investigate the matter, and see if it were really less rare than had been believed." While there is perhaps a *maximum* and a *minimum*

[1] Text-book of Materia Medica, Therapeutics, and Pharmacology, p. 46.

dose for the various drugs, the dose of a remedy should be governed largely by the conditions found at the time the diagnosis is made and the medicine prescribed, taking into consideration the various circumstances which influence the action and effect of drugs. The U.S.P. IX and X recognizing this fact, gives only the "average dose" for an adult. Commenting upon this the U.S.P. states: "It is to be distinctly understood that neither this Convention nor the Committee of Revision created by it intends to have these doses regarded as obligatory on the physician or as forbidding him to exceed them whenever in his judgment this seems advisable." Only the *average dose* of drugs and their preparations will be given in this book.

The age of a patient must be taken into account in the internal administration of drugs. Children or the aged ought to receive much smaller doses than adults. Young calculates the dose for a child according to the following formula: Divide the age by the age + 12, the fraction obtained is taken as the proportion of the adult dose required. Thus, for a child four years old, the dose would be $(\frac{4}{4 + 12} =)$ $\frac{1}{4}$ of the adult dose; for a child twelve years old $(\frac{12}{12 + 12} =)$ $\frac{1}{2}$ of the adult dose.

In regard to the **sex,** women require somewhat smaller doses than men. During *pregnancy*, purgative drugs, or preparations of ergot formerly used frequently in dental practice in cases of hemorrhage after extraction, have to be used with the greatest care, because purgatives induce congestion of the pelvis, and ergot acts directly upon the muscular walls of the uterus, causing contraction, either of which conditions may lead to abortion. Many drugs also pass from the mother to the child, and this should be remembered, as quantities which are insufficient to poison the former may have serious effects upon the latter. During *lactation*, it should be borne in mind that many active drugs may be excreted in the milk, and may either act on the child or render the milk distasteful to it.

Pathologic conditions very often modify the effects of drugs to a considerable extent, and in a way which pharmacologists at present cannot explain. As an example of this, the antipyretics reduce the temperature in fever, but have no effect on it in health; bromids lessen the convulsions in epilepsy, or during the teeth-erupting period in children, but have much less effect in depressing the brain in normal persons. Strange as it may seem to the student or inexperienced practitioner, the **climate** or **temperature** has a controlling influence on the action and effects of drugs, as well as on

pathologic conditions, which fact has been demonstrated by clinical experience. **Race** must also be taken into consideration in relation to the administration of drugs. Those who have been privileged to practice among many different races have observed the racial resistance and reaction to medicines.

The method and time of administration also have some influence on the effects of drugs. It has been mentioned elsewhere that the nearer the site of the disease the remedy is applied the more effectual and safer is its use. It is also true that the body is generally more resistant in the morning than in the evening, especially in the case of hypnotic drugs; thus a dose of chloral hydrate, for example, which may have little or no effect in the morning when the brain is clear and active, induces sound sleep when given in the evening, because the brain now is already fatigued and depressed.

CLASSIFICATION OF MEDICINES

In their attempt to keep pace with the advancement of knowledge, writers upon, and teachers of, Materia Medica, Pharmacology, and Therapeutics have devised, from time to time, various systems of classification of drugs and remedial agents. The unsettled state of knowledge regarding normal physiologic processes and of the physiologic action of remedies upon pathologic conditions which they are expected to correct, is sufficient reason, in the author's opinion, for stating that therapeutics is far from being an exact science—it is an art. At this time, therefore, no really scientific classification of these substances is possible. It is imperative, however, as an aid to the student, that some system of classification be followed, and, inasmuch as the tendency in modern therapeutics is along rational lines, *i.e.*, administering or applying the remedy because of its known pharmacologic action, a system of classification will be followed by which drugs will be divided into local and general remedies, and grouped, so far as possible, according to their physiologic action and therapeutic application. It is important, however, that the student familiarize himself at the beginning of the study of drugs and their uses with the definitions of *remedies* with reference to their action upon the tissues, organs, and functions of the body. Therefore, as an appropriate introduction to that part of this work devoted to *drugs* proper, brief definitions of remedies, alphabetically arranged, are here inserted, together with practical examples of each.

DEFINITIONS OF REMEDIES

Antacids.—These are agents which neutralize acids by reason of their alkaline or basic properties. Examples are:

Sodium Bicarbonate.
Solution of Calcium Hydroxid (Lime-water).
Magnesium Hydroxid (Milk of Magnesia).

Alteratives.—Agents that *alter* or counteract morbid conditions by promoting metabolism or the processes of nutrition. Examples are:

Potassium Iodid.	Arsenic.
Mercury.	Cod-liver Oil.

Analgesics or Anodynes.—These are agents which relieve pain either by direct depression of the centers of perception and sensation in the cerebrum or by impairing the conductivity or receptivity of the sensory nerve fibers. Examples are:

Opium.	The Bromids.
Butyl-chloral Hydrate.	Aspirin.

Anesthetics.—These are agents which temporarily destroy sensation. They are divided into two classes, *local* and *general*. A local anesthetic abolishes sensation in a part, while a general anesthetic abolishes all sensation and induces unconsciousness. Examples are:

Local anesthetics.	*General anesthetics.*
Cocain Hydrochlorid.	Nitrous Oxid.
Eucain Hydrochlorid.	Chloroform.
Procain Hydrochlorid.	Ether.
	Ethyl Chlorid spray.

Antagonists.—These are agents which directly oppose each other in some or all of their pharmacologic actions. Advantage is taken of drugs which antagonize each other in cases of *poisoning*, for antagonistic drugs may antagonize some if not all of the effects of poisonous drugs. Important examples are:

Strychnin and Cocain. Atropin and Morphin.
Caffein and Cocain.

Anthelmintics.—These are agents which destroy (vermicides) or expel (vermifuges) intestinal worms. Examples are:

Pepo (Pumpkin-seed).	Oil of Turpentine.
Thymol.	Santonin.

Antipyretics.—These are drugs or remedies which reduce the body temperature when abnormally high. Examples are:

Aconite.
Quinin.
The Coal-tar Products:
Antipyrin. Acetanilid.
Acetphenetidin (Phenacetin).

Antiseptics.—These are agents which inhibit the growth of microorganisms. Examples are:

Oil of Cloves.
Phenol (5 per cent. solution).
Boric Acid.
Alcohol (20 per cent. solution).
Benzoic Acid.
Sodium Borate (Borax).
Glycerin.
Betanaphthol.

Antispasmodics.—These are agents which control spasms and lessen states of general nervousness. Examples are:

Camphor. Compound Spirit of Ether (Hoffmann's Anodyne).
Valerian.

Astringents.—These are agents which contract or condense tissue. Examples are:

Alum.
Tannic Acid.
Bismuth Subnitrate.
Zinc Chlorid.
Zinc Phenolsulphonate.
Zinc Iodid.
Silver Nitrate.
Copper Sulphate.

Bleachers.—These are agents used to restore the color of tooth-structure. Examples are:

Sodium Dioxid.
Hydrogen Dioxid.
Alphozone.
Chlorin.
Sulphurous Acid.

Carminatives.—These are agents which promote the expulsion of gas from the stomach. Examples are:

Capsicum.
Mustard.
Ginger.
Pepper.
Cinnamon.
Cardamom.

Cathartics.—These are agents used to produce evacuation of the bowels. Cathartic drugs are classified according to the intensity of their action. Thus, those that are mild in action and produce a nearly normal stool are called *laxatives*. Those more powerful, usually producing more copious stools, are termed *purgatives*. Those which produce a watery evacuation of the bowels are called *hydragogues*. Those which gripe, having a violent action, are called *drastics*. Examples of each class follow:

Laxatives.	*Purgatives.*
Tamarind.	Aloes.
Cascara Sagrada.	Senna.
Manna.	Castor Oil.
Honey.	Calomel.
Figs.	Rhubarb.
Prunes.	Blue Mass.
Hydragogues.	*Drastics.*
Magnesium Sulphate.	Croton Oil.
Sodium Sulphate.	Colocynth.
Potassium and Sodium Tartrate (Rochelle Salt).	Gamboge.
Sodium Phosphate.	Jalap.
Magnesium Citrate.	Podophyllum.

Demulcents.—These are substances largely of a mucilaginous nature, which soothe and protect the parts to which they are applied. Examples are:

Acacia.	Marshmallow.
Licorice.	Starch.
Sassafras Pith.	Flaxseed.
Slippery Elm.	White of Egg.

Dentifrices.—These are medicated powders or pastes applied with a suitable brush to cleanse the teeth and gums. Precipitated chalk (calcium carbonate) is the base of nearly all dentifrices. For examples, see Practical Therapeutics, p. 315.

Deodorants.—These are agents which destroy offensive odors. Examples are:

Formaldehyd.	Potassium Permanganate.
Chlorin Gas.	Charcoal.
Hydrogen Dioxid.	Sulphurous Acid.

Diaphoretics or Sudorifics.—These are agents which promote the secretion of sweat. When the action of the remedy is such that the perspiration stands in beads upon the surface, it is called *sudorific*. Examples are:

Pilocarpus (Pilocarpin).	Ammonium Acetate.
Dover's Powder.	Spirit of Nitrous Ether.

Disinfectants or Germicides.—These are agents which destroy microorganisms and their spores. Examples are:

Mercuric Chlorid.	Urotropin.
Formaldehyd.	Hydrogen Dioxid.
Cresol.	Potassium Permanganate.
Phenol.	Silver Compounds.
Thymol.	Betanaphthol.
Heat.	Chlorin Gas.

Diuretics.—These are agents which increase the flow of urine. Examples are:

Potassium Salts.	Spirit of Nitrous Ether (Sweet Spirit of Niter).
Lithium Salts.	
Effervescent Salts.	Caffein.
Theobromin.	

Emetics.—These are agents which produce vomiting. Examples are:

Ipecac.	Alum.
Tartar Emetic.	Mustard.
Zinc Sulphate.	Apomorphin.
Copper Sulphate.	Tepid Water, in quantity.

Emollients.—These are substances which protect, soften, and relax the tissues to which they are applied. Examples are:

Hot Fomentations.	Linseed Oil.
Poultices.	Petroleum.
Lard.	Cacao Butter.
Lanolin.	Glycerin.
Olive Oil.	Almond Oil.

Escharotics or Caustics.—These are agents which destroy the tissues upon which they act. Examples are:

Mineral Acids.	Osmic Acid.
Caustic Alkalies.	Zinc Chlorid.
Phenol.	Sodium Ethylate.
Arsenic Trioxid.	Mercuric Chlorid.
Trichloracetic Acid.	Silver Nitrate.
Actual Cautery.	

Expectorants.—These are agents which modify the secretion of mucus from the mucous membrane of the air-passages and facilitate its expulsion. Examples are:

Ammonium Chlorid.	Squill.
Eucalyptus.	Ipecac.
Potassium Citrate.	

Hypnotics or Somnifacients.—These are agents which produce sleep. Examples are:

Chloral Hydrate.	Pyramidon.
Butyl-chloral Hydrate.	Trional.
Sulphonal.	Paraldehyd.
Opium (and Alkaloids).	The Bromids.

Irritants.—These are agents which, when applied to the skin or mucous membrane of the mouth, cause active hyperemia or inflammation. When they are applied not simply for their local action, but to influence favorably a deep-seated part which is diseased, they are called **counterirritants.** Irritants are largely used for the latter purpose in dental practice. Examples are:

Iodin.	Aconite.
Mustard.	Chloroform.
Capsicum.	Volatile Oils.
Camphor.	Menthol.

Mydriatics.—These are agents which produce dilatation of the pupil of the eye. Examples are:

Atropin.	Homatropin.
Hyoscyamin.	Cocain.

Anesthetics (late in their action).

Myotics.—These are agents which produce contraction of the pupil of the eye. Examples are:

Physostigma, Eserin.	Anesthetics (early in their action.)
Opium, Morphin.	

Narcotics.—These are agents which produce stupor. Examples are:

Opium (and Alkaloids).	Chloroform.
Alcohol.	Ether.

Restoratives.—These are agents, somewhat similar to alteratives, which promote constructive metamorphosis. Restoratives include:

FOODS, HEMATICS, AND TONICS

Foods are substances which, when introduced into the body, supply material to renew some structure or to maintain some vital process. They differ from medicines in that the latter modify vital processes, but furnish no material to sustain such.

Hematics are medicines which increase the hematin in the blood, and enrich the red blood-corpuscles. The compounds of iron are the principal hematics.

Tonics are agents which improve the tone and give strength and energy to the tissues. Among the tonics are:

Iron and Compounds.	Cod-liver Oil.
Phosphorus.	Nux Vomica.
Calcium Phosphate.	Cinchona.
Hypophosphites.	Arsenic.

Sedatives.—These are agents which exert a soothing influence on the system by lessening functional activity and diminishing pain. They have been largely considered in other classes of remedies, as: *General sedatives* include anesthetics and narcotics. *Nervous sedatives* include the bromids, tobacco, etc.

Sialogogues.—These are agents which stimulate the salivary and buccal mucous glands, increasing the secretion and flow of saliva and buccal mucus. Holding the mouth open, as in dental operations, changes the character and flow of the mouth secretions. Examples of drugs producing this effect are:

Pilocarpus (Jaborandi).	Iodin Compounds.
Mercurials.	Tobacco.
Echinacea, Echafolta.	Potassium Chlorate.

Stimulants.—These are agents which increase the activity of an organic function or process. When applied to medicinal agents the term is used in various senses, for different agents stimulate the functional activity of the various organs of the body. As examples we have:

Cardiac.	*Respiratory.*	*Gastric.*	*Restorative.*
Strychnin.	Atropin.	Gentian.	Physiologic Salt Solution.
Digitalis.		Bitter Tonics.	
Caffein.			
Alcohol.			

Styptics and Hemostatics.—These are agents which arrest hemorrhage. When the agent is applied locally it is called a *Styptic;* when administered internally it is called a *Hemostatic*. Examples are:

Styptics.	*Hemostatics.*
Acids.	Ergot.
Alum.	Gallic Acid.
Ferric Subsulphate.	Hamamelis.
Adrenalin Chlorid.	Fibrin Ferments and Thrombo-
Cauterization.	plastic Substances.

DRUGS

As stated elsewhere, an effort will be made to divide drugs into *local* and *general remedies*, and group them, so far as possible, according to their physiologic action and therapeutic application. Those drugs which are largely applied *locally* in dental practice will first be considered.

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LOCAL REMEDIES

ANTACIDS

Antacids are agents which neutralize acids by virtue of their alkaline or basic property. All acids, whether mineral or organic, have a destructive action on the tooth-structure. Acids are found in the mouth as a result of the fermentation of carbohydrate food-stuffs, from eructations of the stomach, and from perverted buccal mucous glands. Agents which are capable of neutralizing acids, therefore, have an important rôle to play in the broad field of *oral prophylaxis*. They form the base of nearly all dentifrices and enter as an essential constituent into most of the mouth-washes on the market. The most important antacids are:

Precipitated Calcium Carbonate.	Sodium Borate (Borax).
Lime-water.	Magnesium Oxid.
Sodium Bicarbonate.	Soap.

CALCII CARBONAS PRÆCIPITATUS—U.S.P.

(Precipitated Calcium Carbonate; Precipitated Chalk; $CaCO_3$.)

Formerly there were two official forms of chalk: **Precipitated calcium carbonate** and **prepared chalk.** The former is the only form recognized in the U.S.P. IX and X and is made by mixing aqueous solutions of calcium chlorid and sodium carbonate, the resulting precipitate of calcium carbonate being purified. The latter is native calcium carbonate, freed from most impurities by elutriation (washing). Precipitated calcium carbonate occurs as a fine, white, micro-crystalline powder, odorless and tasteless, and permanent in the air, nearly insoluble in water; the solubility is increased by the presence of ammonium salts and especially by carbon dioxid. It is insoluble in alcohol. The average dose is 15 gr. (1.0 Gm.).

Therapeutics.—Chalk is an antacid and mild astringent. It is an excellent antacid when the acidity of the fluids of the mouth is due to eructations from the stomach. It may be prescribed as an *antidote* in general poisoning by any of the *mineral acids* or by *oxalic acid*, care being taken to avoid the rapid evolution of large quantities of gas (CO_2). Because of its antacid properties and its almost absolute insolubility, it enters into the composition of nearly all dentifrices, forming the base of most *tooth-powders* and *pastes*.

LIQUOR CALCIS—U.S.P.

(Solution of Calcium Hydroxid; Lime-water; $Ca(OH)_2$.)

Lime-water is a saturated solution of pure calcium hydroxid in water. The liquid should be clear and colorless, without odor, and having a saline and feebly caustic taste. It should contain not less than 0.14 per cent. of calcium hydroxid. When administered internally the average dose is 4 fl. dr. (15.0 cc.). A useful official preparation is Linimentum Calcis (equal volumes of lime-water and linseed oil).

Therapeutics.—In all cases where cows' milk is the chief article of diet, as in the artificial feeding of children, lime-water should be added to the milk to prevent the formation of hard curds in the stomach. In cases of *obstinate vomiting*, as in pregnancy, when the vomiting or eructations are due to a high degree of acidity, it is a useful remedy. In *chronic catarrh* with an excessive secretion of mucus, lime-water diluted with two-thirds cinnamon water, to which a small amount of alcohol is added, can be used as a spray and for rinsing the mouth and brushing the teeth, gums, and tongue with gratifying results. The official liniment, called also Carron Oil, is employed as a soothing application for *burns* and *scalds*. One dram of chloretone added to eight ounces of Carron Oil makes an excellent lotion. A "shake label" should be placed on the container. This remedy will be found of special value in relieving the pain and soreness resulting from *sunburn*.

SODII BICARBONAS—U.S.P.

(Sodium Bicarbonate; $NaHCO_3$.)

Sodium bicarbonate is a white, opaque powder, without odor, and having a cooling and slightly alkaline taste. It is freely soluble in water, 1 part dissolving in 10 parts of water at 25°C.; insoluble in alcohol. The average dose is 15 gr. (1.0 Gm.). The U.S.P. IX recognized a troche of this drug. It was deleted in the U.S.P. X. It is an important preparation for use in dental therapeutics and is here given:

> Trochisci Sodii Bicarbonatis (containing about 2½ gr. (0.18 Gm.) each).

Therapeutics.—Sodium bicarbonate is extensively used to neutralize the excess of hydrochloric acid or abnormal acids in the stomach. Given in the form of a troche an hour or two before meals, it allays the burning pain, eructations, and palpitations caused

by the *acids of fermentation.* "Soda Mint Tablets" contain sodium bicarbonate and oil of peppermint, and are better for this purpose than the simple troches.

Sodium bicarbonate is often applied externally as a sedative dressing for *superficial burns.* A 5 to 10 per cent. solution has been used in cases of *thrush* with excellent results. It is an ingredient of the popular Dobell's solution (see p. 316) and used as an antacid or detergent in many mouth-washes. Sodium bicarbonate is added to the water in which instruments are boiled for sterilization to prevent the latter from rusting. Sodium carbonate and borax are also used for this purpose. When acids are employed in root-canals, they should subsequently be neutralized with some ant-acid, and nothing is better than a solution of sodium bicarbonate. The agent not only neutralizes the excess acid, but the effervescence produced removes from the canal all of the "mushy" and disintegrated material; thus leaving it clean and sterile. The powder is used by direct application to lessen the hypersensitiveness of dentin when due to acidity. In the treatment of pyorrhea and oral prophylaxis, the teeth, oftentimes after the scaling and polishing, are extremely responsive to thermal changes, especially where the gums have receded, exposing the cementum. This can be controlled by warm solutions of the drug.

It is stated in many clinical, pharmacologic and physiologic text-books that the alkaline salts of sodium promote a flow of gastric juice. Pawlow, Sippy, Stone, and other internists claim that clinical experience does not confirm this theory. In fact, it has been shown that alkalies exert a distinct inhibitory influence on the gastric glands, separate and distinct from their neutralizing effects on acids already present in the stomach. Sodium bicarbonate 20 parts, heavy magnesium oxid 5 parts, and bismuth subcarbonate 5 parts make an excellent "alkaline powder" to be taken after meals in from one-half to one teaspoonful doses in cases of *hyperacidity of the stomach, gastric* and *duodenal ulcers.* The powder should be taken in a small quantity of water, thoroughly agitated, as the magnesia oxid and bismuth salt do not dissolve in the water.

Incompatibilities.—Sodium bicarbonate is incompatible with acids, metallic salts, and alkaloids.

SODII BORAS—U.S.P.

(Sodium Borate; Sodium Pyroborate; Borax; $Na_2B_4O_7.10H_2O$.)

Borax occurs in colorless, transparent, monoclinic prisms, or white powder; inodorous, and of a sweetish, alkaline taste. It is

soluble in about 16 parts of water and 1 part of glycerin, and is insoluble in alcohol. The average dose is 12 gr. (0.75 Gm.). An official preparation for external use containing a small amount of borax is:

Unguentum Aquæ Rosæ (Cold Cream).

Theapeutics.—The alkaline and antiseptic properties of borax make it a useful drug. It is a valuable ingredient in mouth-washes possessing the above qualities, and can be used freely in saturated solution (6½ per cent.) in cases of *stomatitis* and in *thrush*. In the latter disease, which generally occurs in the mouths of infants where it is impracticable to use a mouth-wash to advantage, a saturated solution in glycerin, made by dissolving the drug in hot glycerin, can be employed. This thick, sweet solution should be applied by means of a swab to the mucous membranes of the infant's mouth. A saturated solution in a 10 per cent. formaldehyd solution makes an excellent sterilizing fluid for small instruments. The borax prevents the formaldehyd from attacking the metal. A good collyrium (eye-water) can be made by adding 2 per cent. of borax to a saturated solution of boric acid.

In the treatment of *epilepsy* borax is a useful remedy when, for any reason, the bromids are contraindicated.

Incompatibilities.—Borax is incompatible with acids, metallic salts, and alkaloids, and glycerin slowly converts it into boric acid.

MAGNESII OXIDUM—U.S.P.

(Magnesium Oxid; Light Magnesia; Calcined Magnesia; MgO.)

Light Magnesia is a white, very bulky, and very fine powder, without odor, and having an earthy-like taste. It is practically insoluble in water, and insoluble in alcohol, but chemically soluble in dilute acids. The average dose is 30 gr. (2.0 Gm.). An important official preparation is:

Ferri Hydroxidum cum Magnesii Oxido (Arsenic Antidote).

Therapeutics.—The preparation of ferric hydrate with magnesia has long been recognized as an efficient antidote in *arsenical poisoning*. Other compounds of magnesia, recognized by the U.S.P., are **Magnesii Oxidum Ponderosum, Heavy Magnesia** (**Magnesia Oxid**—3½ times as heavy as light magnesia) and **Magnesii Carbonas, Magnesium Carbonate.** Both have practically the same properties and uses as light magnesia. Magnesium carbonate, however, should be used cautiously when there is much acid in the

stomach on account of the unpleasant eructations of gas (CO_2). Magnesium carbonate, being cheap and insoluble, is often substituted for talc or precipitated calcium phosphate in the preparation of the aromatic waters. The suspended precipitate of magnesium hydrate, commercially called milk of magnesia, is a useful antacid. In cases of *erosion of the teeth*, in *pregnancy*, and other conditions wherein the mouth secretions are acid in reaction, it can be used to advantage by coating the exposed tooth-surfaces with it. Its gelatinous consistence causes it to adhere and remain for a considerable length of time, especially if applied on retiring at night when the jaws and buccal tissues are at rest.

In cases of *hyperacidity of the stomach,* due either to an excess of hydrochloric acid or the acids of fermentation, Sippy recommends an average dose (30 gr.–2.0 Gm.) each of heavy magnesia and sodium bicarbonate; this to be taken in a small amount of water soon after each meal. Besides these antacids, the proper diet must be observed and 1 fl. oz. (30.0 cc.) each of milk and cream should also be taken after the meal. Magnesia is partly converted by the acids of the stomach into soluble salts that act as laxatives; hence, when internally administered, the antacid properties of magnesia are combined with those of a mild aperient or laxative.

SAPO—U.S.P.

(Soap; White Castile Soap.)

The only official **soap** is white castile soap, made by boiling olive oil with sodium hydroxid. Any fat boiled with sodium or potassium hydroxid will form soap. Hard soap is a sodium soap, soft soap is a potassium soap. White castile soap should be hard, but easily cut when fresh, easily pulverized when dry, and free from rancid odor. It has a rather unpleasant taste and an alkaline reaction, hence it is an antacid, soluble in water and in alcohol.

A useful preparation is:

> Linimentum Saponis Mollis—U.S.P. (Liniment of Soft Soap, Tincture of Green Soap).

Therapeutics.—White castile soap is alkaline in reaction and somewhat antiseptic, possessing detergent properties to a marked degree. The greatest value of soap lies in its power to dissolve fats. Advantage is taken of this fact in bleaching teeth, as will be explained in Practical Therapeutics (p. 492). White castile soap is chiefly used in dental practice as a constituent of dentifrices, both tooth-powders and tooth-pastes. The preparation should not contain more

than about 15 per cent.; for, in greater quantities, too much suds is formed in the mouth by its employment. The preparation known as tincture of green soap is a valuable toilet article for dentists' hands.

Incompatibilities.—Soap is incompatible with all acids and with earthy and metallic salts. It is precipitated in hard water (containing calcium and magnesium salts) as an insoluble soap.

ANTISEPTICS, DISINFECTANTS, AND DEODORANTS

The term **antiseptic** has been defined elsewhere as applying to that class of remedies which inhibit or have a restraining influence on the life and activity of microorganisms. The terms **disinfectant** and **germicide** have been previously referred to as applying to that class of remedies which destroy microorganisms and their spores. Some authors have endeavored to distinguish between the two latter terms, using the term germicide in the sense that the agent simply kills the germ, and disinfectant in the sense that the agent not only kills the germ, but also acts upon the noxious products of putrefaction and fermentation. As a matter of fact, this distinction is largely theoretical, for there are few agents which, if used in sufficient strength to kill the germ, will not also act upon and thus destroy or remove the by-products of germ-growth. In this work, therefore, the term disinfectant will be used in preference to the term germicide, and for the reason given. A **deodorant** is an agent which destroys offensive odors, and inasmuch as the odor generally comes from the noxious products of putrefaction, the deodorization results from true disinfection. Therefore, deodorants will be discussed conjointly with antiseptics and disinfectants.

Many agents belong to both the antiseptic and disinfectant classes of remedies, depending upon the strength in which they are employed. In weak solutions they act as antiseptics; in strong solutions, as disinfectants. These two classes of remedies are among the most important classes employed in dental practice, and it is well that the student should understand at the outset the significance of these remedies as well as several terms employed in connection therewith.

Sterilization is the process of making sterile by destroying or removing all germ life. The term **disinfection** is employed more particularly to designate the use of chemicals in destroying bacteria. **Terminal disinfection** indicates the process of rendering the personal clothing and immediate physical environment—house, rooms, etc., of the patient free from the possibility of conveying the infection to

others, at a time when the patient is no longer a source of infection. By **fumigation** is meant a process by which the destruction of insects (mosquitoes and body lice), as well as animals (rats, mice, etc.), and the so-called "scale" on citrus fruit trees, is accomplished by gaseous agents (SO_2, Cl, etc.). **Pasteurization** is the process of cautiously heating any substance to 60°C. for 20–30 minutes. It is appropriate only when the organisms to be killed are without spores and without marked resisting powers. The process is used for the destruction of bacteria in milk and other fluids that would be impaired by coagulation or other changes taking place at high temperatures. **Sterilization by filtration** is a process employed when it is not possible to subject substances to heat without causing injury to them. Such substances are filtered through unglazed porcelain, the pores of which are so fine that the bacteria are held back while the fluid passes through. This method is used for sterilizing drugs, bacterial toxins and antitoxins, and certain culture-medium materials, such as blood serum and ascitic fluid. Several filters are on the market for this purpose. In every case the filter must be tested to make sure it is sound and free from fissures; it must always be sterilized immediately before use, and subsequent contamination must be carefully guarded against.

In all surgical work the ideal condition sought is the absence of disease-producing germs (asepsis), rather than to depend upon the chemic destruction of them at the time of operating. With this end in view, the instruments are sterilized by boiling, and the site of operation as well as the operator's hands are disinfected by washing in certain solutions. Strictly speaking, infected animal tissue cannot be sterilized by employing disinfectants. An ideal disinfectant would be an agent which, employed in certain strength solution in a septic process or disease, would kill the disease-producing germ and destroy or remove the poisonous by-products without acting deleteriously upon the animal cell. But bacteriologists inform us that the cell-wall of a vegetable cell (bacteria) is less permeable to disinfecting agents than is the cell-wall of the animal cell. Therefore, in our present state of knowledge we should not employ disinfectants in our effort to kill the germ when its habitat is among living animal cells. It becomes necessary, then, to attack these germs in another manner. This can be done by the use of certain antiseptic agents which check the growth and activity of the germs, cripple them, as it were, and which agents also are just sufficiently irritating to the animal cells to produce stimulation. This stimulating or awakening process on the part of the animal cells will cause the latter to attack and des-

troy the already crippled vegetable cells, thus bringing about nature's method of sterilization. In the treatment of infected wounds, Carrel, of the Rockfeller Institute, differentiates between *absolute* sterility and *surgical* sterility. This author claims that in such cases absolute sterility is neither necessary nor desirable—a degree of sterility known as surgical sterility is all that is required. Later on the student will learn to distinguish between the "presence of germs" and "infection."

When the germs which we are endeavoring to destroy are among the contents of a gangrenous root-canal, for example, surrounded by hard tooth-structure and removed from live animal tissue, the problem presents an entirely different aspect. Here true disinfectants can be employed. The fact that a remedy will destroy microorganic life in a certain length of time in a test-tube, or in a gangrenous root-canal, is no criterion that the remedy, as such, can be used for disinfecting the soft tissues of the mouth or for treating an infected wound.

The chief antiseptics are:

Boric Acid.
Borax.
Benzoic Acid.
Salicylic Acid.
Salol.
Salophen.
Sodium Salicylate.
Iodin and Compounds.
Betanaphthol.
Resorcin.
Silver Compounds.
Many Volatile Oils:
  Oil of Cajuput.
  Oil of Cinnamon.
  Oil of Cloves.
  Oil of Eucalyptus.
  Oil of Peppermint.
  Oil of Thyme.
Charcoal.
Calendula.
Arnica.
Myrrh.
Ozone and Oxygen.

The chief disinfectants are:

Phenol.
Cresols.
Creosote.
Formaldehyd.
Urotropin.
Sodium Perborate.
Hydrogen Dioxid.
Potassium Permanganate.
Chinosol.
Heat.
Mercuric Chlorid (Discussed under Mercury in *Alteratives*).
Mercurochrome—220.
Chloramin and Dichloramin.

ACIDUM BORICUM—U.S.P.

(Boric Acid; Boracic Acid; H_3BO_3.)

Boric acid occurs in transparent, colorless, pearly scales or crystals, nearly colorless and of a somewhat bitterish taste, and slightly unctuous to the touch. It is soluble in about 18 parts

of water and alcohol, and 4 parts of glycerin at 25°C. When given internally the average dose is 8 gr. (0.5 Gm.).

It enters into two official preparations which are valuable in dental practice. They are:

> Glyceritum Boroglycerini, Glycerite of Boroglycerin (contains 31 per cent. of boric acid in glycerin).
> Unguentum Acidi Borici, Ointment of Boric Acid (10 per cent.).
> Liquor Antisepticus, Antiseptic Solution (contains 2 per cent. of boric acid, 0.1 per cent. each of benzoic acid and thymol, 25 per cent. of alcohol, and minute quantities of eucalyptol, oil of peppermint, oil of gaultheria, and oil of thyme, in an aqueous vehicle). N.F.

Physiologic Action.—Boric acid is a nonirritating antiseptic and deodorant. In quantities generally employed by dentists, boric acid produces no appreciable symptoms. It is rapidly absorbed and rapidly eliminated by the saliva, perspiration, feces, and urine —the bulk of it escaping in the urine within twenty-four hours after its administration. It is not a drug to be used indiscriminately, for repeated external applications have led to the same train of symptoms as those observed following the continued internal administration of the drug. The term *borism* has been applied to this condition, and the most important phenomena are digestive disturbances, dryness of the skin and mucous membranes, and a tendency toward certain rashes. The drug has been used as a preservative of milk and foods, and there is a difference of opinion among investigators as to whether or not boric acid has a deleterious action when so used.

Therapeutics.—Boric acid is a constituent of many mouth-washes. It is largely employed in a saturated aqueous solution (5 per cent.) as an antiseptic and stimulating wash. Because of its nonirritating properties it can be applied to the most sensitive tissue. A good collyrium (eye-wash) can be made by adding 10 gr. (0.6 Gm.) of borax to 1 fl. oz. (30.0 cc.) of the saturated solution of boric acid. Lotions, ointments, and dusting-powders containing boric acid are used to advantage in many acute inflammatory conditions of the mucous membranes and skin. As a stimulating and antiseptic mouth-wash there are few better than the formerly official liquor antisepticus.

Probably the only objection to boric acid as a constituent of mouth-washes is its *slightly acid* reaction and rather sparing solubility in water. Whenever a stronger solution than the saturated is desired, the official glyceritum boroglycerini (glycerite of boroglycerin) can be used. This is *neutral* in reaction and can be em-

ployed in full strength or diluted. However, strong solutions should not be used continuously on account of the tendency to produce borism.

Incompatibilities.—In aqueous solution it will decompose carbonates and bicarbonates.

SODII BORAS—U.S.P.

Borax.—This salt has been fully discussed under Antacids (see p. 42). Its antiseptic and alkaline properties give it a prominent place among dental remedies. The physiologic action of borax closely resembles that of boric acid, for which it is often substituted to good advantage, especially in mouth-washes where it is desired to have an alkaline solution, and in tooth-powders and pastes. Boric acid, as well as all other acids, is incompatible with carbonates, and as calcium carbonate (chalk) is the base of nearly all dentifrices, boric acid should not be a constituent. Here the sodium salt, borax, can be employed with the same result without any reaction (incompatibility) between the ingredients of the mixture.

A saturated solution of borax, by the aid of heat, can be used as a solvent for shellac. In this manner a cheap and convenient solution can be prepared for use in the dental laboratory as a *separating fluid*.

Borax is also used as a *flux* in soldering, and is an essential constituent of the prepared fluxes and soldering fluids on the market. Nearly all metals have an affinity for oxygen, which is greatly increased by heat; and in the soldering process it is necessary to prevent the rapid oxidation of the base metals in the alloys used. Fluxes are used for this purpose which, when fused over the surfaces to be united, keep them clean and free of oxidation, which aids in the fusing and alloying of the parts. It is equally important that the solder as well as the metal be fluxed, for, being a lower grade alloy, it is more readily oxidized. Borax used alone as a flux meets every requirement and is the substance most generally used for the purpose. Goslee cautions against using it in powdered form and in greater quantities than necessary for the following reasons: When heated powdered borax expands to the extent that it may cause the investment to split and change the relation of the parts; it always displaces the solder, and generally results in a pitted surface. To prevent this borax should be mixed with clean water to the consistency of a thin paste, and applied, before heating the parts, with a small camel's hair brush. This admits of its application to the particular surfaces in the proper and necessary amounts.

Parr's fluxed wax is a hard wax containing borax and is much used in dental soldering—it is a convenient form of flux, as the wax readily burns out, leaving the borax deposited upon the surfaces in correct amount and in the right place.

Liquid soldering fluid has been used extensively in recent years in dentistry, and is considered the best, cleanest, most desirable and convenient flux for the dentist as well as the jeweler. It is a saturated solution of equal parts of borax and boric acid.

ACIDUM BENZOICUM—U.S.P.

(Benzoic Acid; $HC_7H_5O_2$)

Benzoic acid is an organic acid obtained from benzoin and balsam of Peru, or prepared synthetically. It occurs in white or slightly yellow scales or needle-shaped crystals of an aromatic odor and taste. It is sparingly soluble in water, but with an equal quantity of borax it can be dissolved to the extent of 1 per cent., freely soluble in alcohol and glycerin. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action.—Benzoic acid has proven to be an antiseptic of considerable power. Long states that a solution of 1 :400 has been found to destroy developed bacteria. It also acts as a stimulant to mucous membranes. Internally administered it increases, to a variable degree, the nitrogenous output and lessens the quantity of ethereal sulphates and indican in the urine. In large doses benzoic acid and benzoates have an irritant action on the stomach, and in consequence excite nausea and vomiting (Stevens).

Therapeutics.—It is found that a saturated solution of borax (6¼ per cent.) will dissolve 1 per cent. of benzoic acid and still be alkaline. This is doubtless due to a reaction between the substances whereby sodium benzoate is formed, which is freely soluble. In this way it may be employed as a constituent of mouth-washes. It possesses no advantage over the sodium salt, which had better be employed direct. Sodium benzoate is an excellent constituent of dentifrices and also used as an essential ingredient in cough mixtures. In the form of the benzoates it has been recommended in *rheumatism* or the *gouty diathesis*, but is not so efficacious as the salicylates. When administered internally the drug apparently lessens putrefaction in the intestine, as is observed in the diminution of the double sulphates and indican of the urine. Balsam of Peru, which contains benzoic acid, is used externally as a parasiticide in *scabies* (itch). The acid is frequently added to ointments to prevent rancidity.

Incompatibility.—Benzoic acid in the presence of moisture will react upon carbonates and bicarbonates. It should not be employed, therefore, as a constituent of dentifrices with calcium carbonate as the base.

ACIDUM SALICYLICUM—U.S.P.

(Salicylic Acid; $HC_7H_5O_3$.)

Salicylic acid is an organic acid obtained from various plants, especially from gaultheria (wintergreen), but it is chiefly prepared synthetically. It occurs as a white crystalline powder, or in fine needle-shaped crystals, or as a bulky crystalline powder, odorless, but possessing a sweetish, afterward acrid taste. It is soluble in about 460 parts of water, 13 parts of alcohol, and 60 parts of glycerin at 25°C. The average dose is 12 gr. (0.75 Gm.).

Physiologic Action.—Salicylic acid, like many other drugs, acts differently upon different individuals and upon the same individual at different times. In susceptible subjects even small doses give rise to a peculiar feeling of fullness in the head, ringing in the ears, and, at times, interference with the senses of hearing and sight, causing deafness and dimness of vision. It enters the circulatory fluids as an alkaline salicylate, and is eliminated from the body in most of the secretions, but principally in the urine. It is claimed on good authority that it increases the output of urea and uric acid.

Therapeutics.—This drug must be classed with our best antiseptics. Miller has shown that a 1 per cent. solution of salicylic acid will disinfect the mouth, as ordinarily considered, in one-quarter of a minute. It must not be forgotten, however, that the mouth cannot be disinfected in the true sense of the term. Its sparing solubility in water and its *acid* character render it practically useless as a constituent of mouth-washes, unless a salt, like borax, or alcohol be added to the solution. The chief use of salicylic acid and its compounds is in *acute rheumatism*, in which condition they are considered *specific remedies*. In excessive doses it may cause dizziness and give a subjective sense of turning—everything in the room appearing to move around the afflicted one. In some diseases, as certain kinds of *periodontoclasia*, which seem to be related to the rheumatic diathesis, salicylic compounds have proven to be efficacious. Dissolved in collodion, a dram (4.0 Gm.) to the ounce (30.0 cc.), it has been long used with success in removing *corns* and *warts*.

Incompatibilities.—Salicylic acid will react with carbonates, potassium chlorate, and potassium permanganate.

PHENYLIS SALICYLAS—U.S.P.

(Phenyl Salicylate; Salol; $C_6H_5C_7H_5O_3$.)

Salol is prepared by heating salicylic acid with phenol in the presence of phosphorus pentachlorid. It occurs as a white crystalline powder, of a faintly aromatic odor, and slightly sweetish taste; practically insoluble in water, but soluble in alcohol, and freely so in ether, chloroform, and in fixed and volatile oils. The average dose is 5 gr. (0.3 Gm.).

Physiologic Action.—Salol acts as an antiseptic like either of its constituents, salicylic acid and phenol. It is not a disinfectant, as it will not destroy bacteria, although it prevents their proliferation. It differs from salicylic acid in its action in that it is not irritating to the mucous membrane. Salol resists to a great extent the action of the gastric juice, passing through the stomach practically unchanged, but is gradually broken up in the intestine by the alkaline fluids into salicylic acid (60 parts) and phenol (40 parts).

Therapeutics.—On account of its insolubility in water, salol is not employed, to any extent, as a local antiseptic, except at times in alcoholic solution, as in mouth-washes. We find its chief use as an intestinal antiseptic. It is claimed by some authorities to be even a better urinary antiseptic than intestinal, for often it is quickly broken up and absorbed before it travels far in the intestine. This explains why it frequently fails to give results as an intestinal antiseptic. Like other salicylic compounds, it is used in the various forms of *rheumatism*. It may be prescribed in powders or capsules in *diarrheas* and other intestinal fermentations. Large doses must be avoided on account of the possible poisoning by phenol, which is liberated.

In cases of *neuralgia* associated with rheumatism, the salicylates combined with some hypnotic drug are especially indicated. A powder composed of 5 gr. (0.3 Gm.) of salol and 4 Gr. (0.27 Gm.) of phenacetin to the dose is a useful combination.

ASPIRIN (Nonofficial)

(Acetyl-salicylic Acid; $C_9H_8O_4$.)

Aspirin is the acetyl derivative of salicylic acid. It is prepared by the prolonged heating of 50 parts of salicylic acid and 75 parts of acetic anhydrid at about 150°C. under a reflux condenser, and subsequently purified by recrystallization from chloroform. It occurs in the form of small, colorless, crystalline needles, odorless, and having

an acidulous taste; soluble in 100 parts of water, freely soluble in alcohol and ether. Boiling water decomposes the drug into acetic acid and salicylic acid or a salicylate. The average dose is 5 gr. (0.3 Gm.) in capsules or wafers. It should be dispensed in wax paper, free from moisture.

Physiologic Action and Therapeutics.—Aspirin passes through the stomach unchanged, the decomposition being in the intestine. Its action is similar to that of salicylic acid, over which it possesses the advantage of producing less of the undesired local and systemic side effects, due to the slow liberation and assimilation of the salicylic acid. The promiscuous use of aspirin by the laity, especially for the relief of headache, has frequently led, even in small doses, to cases of rather severe poisoning; the chief symptoms being edema (swelling) of the lips, tongue, eyelids, nose, or entire face, and occasionally an erythematous rash. Some individuals are especially susceptible to the drug and these symptoms are usually ascribed to an idiosyncrasy. Aspirin is especially useful in cases of *rheumatism* of a neuralgic character.

Incompatibles.—Heat, moisture, alkalies, their carbonates and bicarbonates. It keeps well when properly protected.

SALOPHEN (Nonofficial)

(Acetyl-paramino-phenyl Salicylate; $C_7H_5O_2$.)

Salophen is an unofficial compound of salicylic acid, and is prepared by a chemic process similar to that of preparing salol. It occurs in white scales, tasteless and odorless; insoluble in water, but soluble in alcohol and ether. The average dose is 5 gr. (0.3 Gm.). On account of the liability to poisoning from the phenol which is liberated in the intestine from salol, this compound was introduced. It contains about 50 per cent. of salicylic acid, and is decomposed by the alkaline fluids of the intestine into salicylic acid and a comparatively nonpoisonous compound, acetyl-paramino-phenyl. The action of salophen is similar to that of other salicylic compounds. While it is not as efficacious in *rheumatism* as sodium salicylate, being tasteless and unirritating to the stomach it can be given before meals in the milder manifestations of the disease. In cases of *neuralgia* of rheumatic origin associated with acute pain, salophen may be combined with such drugs as phenacetin and codein sulphate. A powder composed of 5 gr. (0.3 Gm.) each of salophen and phenacetin and ¼ gr. (0.016 Gm.) codein sulphate is a valuable combination.

SODII SALICYLAS—U.S.P.

(Sodium Salicylate; $NaC_7H_5O_3$.)

Sodium salicylate occurs as a white amorphous powder, without odor, but of a sweetish, saline taste. It is freely soluble (0.9 part) in water, in 9 parts in alcohol, and in glycerin at 25°C. The average dose is 15 gr. (1.0 Gm.).

Physiologic Action and Therapeutics.—The action of this salt is the same as that of salicylic acid. It has the advantage, however, of being more soluble and less irritating to the stomach. It is probably the most generally used of all the salicylic compounds, and is especially indicated in the *acute stage of rheumatism.* In cases of *pyorrhea* associated with rheumatism it may be given in 5 gr. (0.3 Gm.) doses after meals, well diluted with water.

Sodium salicylate is discussed here more because of its relation to the previously considered drugs than because of its antiseptic properties. It is not considered a very efficient antiseptic.

VOLATILE OIL GROUP

A true classification of this general group is not practicable. The volatile oils vary so markedly in their physical and chemic make-up that only those which possess antiseptic properties, and are employed in dental practice as such, will be considered here. As a class the volatile oils have enjoyed a wide range of usefulness as antiseptic remedies in the past. They are sparingly soluble in water, but freely soluble in alcohol. Some are useful remedies to be applied to carious cavities in vital teeth, where the pulp is involved, because of their penetrating and slightly analgesic properties. Those which are just sufficiently irritating to stimulate the pulp to healthy activity are the ones especially indicated for this purpose. These will be mentioned later. For years the volatile oils were employed in an effort to disinfect gangrenous root-canals. In this they have proved to be a dismal failure. Here the noxious products of pulp decomposition are surrounded by hard tooth-structure and removed from live animal tissue; therefore, we are justified in using true disinfectants—agents which will kill the germs and destroy their by-products. To use any of the essential oils for this purpose to-day, is but to adhere to the old empirical method of treatment.

OLEUM CAJUPUTI—U.S.P.

(Oil of Cajuput.)

Oil of cajuput is a thin, bluish-green, volatile oil distilled from the *fresh leaves* and *twigs* of *Melaleuca Leucadendron,* a small tree

growing in the East Indies. It has a camphoraceous odor and an aromatic, bitter taste. Its chief constituent is *cineol*, of which it should contain not less than 55 per cent. by volume. The average dose is 8 min. (0.5 cc.).

Physiologic action and therapeutics resemble those of oil of cloves and oil of eucalyptus.

OLEUM CINNAMOMI—U.S.P.

(Oil of Cinnamon, Oil of Cassia.)

Oil of cinnamon is a yellowish or brownish volatile oil distilled from the *bark* of the *shoots* of *Cinnamomum Cassia*, a tree which grows in China. The oil is sometimes commercially called oil of cassia, and the U.S.P. IX recognized it by this name. A species of cinnamon which grows in the Ceylon Islands produces a volatile oil having a finer flavor, though less employed. It has the characteristic odor of cinnamon and a spicy, burning taste. The chief constituent of oil of cinnamon is *cinnamic aldehyd*, formerly official and of which it should contain not less than 80 per cent. by volume. The average dose is 3 min. (0.2 cc.). There are two official preparations of oil of cinnamon; both are valuable in dental practice.

Aqua Cinnamomi (Cinnamon Water), used as a spray and as a vehicle for mouth-washes.
Spiritus Cinnamomi (Spirit of Cinnamon) used largely as a flavoring agent.

CINNALDEHYDUM (Nonofficial)

(Cinnamic Aldehyd; C_9H_8O.)

Cinnamic aldehyd is a colorless liquid obtained from the oil of cinnamon or prepared synthetically. It has a cinnamon-like odor, and a burning, aromatic taste. Sparingly soluble in water, freely in alcohol, fixed and volatile oils. Pure synthetic cinnamic aldehyd has largely displaced the natural oil of cinnamon and may be used for nearly all purposes for which the latter is employed. The average dose is the same as oil of cinnamon.

Physiologic Action.—Oil of cinnamon and cinnamic aldehyd are active antiseptics. Both are rather irritant to the pulp and pericemental membrane. Cinnamon is an agreeable aromatic stimulant, carminative, and stomachic. It is also claimed to possess feebly astringent properties. It enters into aromatic fluid extracts and also into many of the compound tinctures.

Therapeutics.—Oil of cinnamon has been employed in root-canal treatment, but because of its irritant properties and of its liability to stain the tooth-structure, it should be used cautiously, if at all. It is a constituent of Black's 1–2–3 mixture which contains oil of cassia 1 part, oil of wintergreen 2 parts, and phenol (carbolic acid) 3 parts. The most practical use that can be made of oil of cinnamon in dental practice, however, is as a flavoring agent. The official water may be employed as a vehicle for mouth-washes and sprays. Every dentist should know how to prepare the solution (see p. 12), as it should be freshly made and used freely in prophylactic and phyorrheal treatment. It is claimed that oil of cinnamon, internally administered, stimulates the formation of white blood-cells.

OLEUM CARYOPHYLLI—U.S.P.

(Oil of Cloves.)

Oil of cloves is a thin, pale yellow, volatile oil distilled from *cloves*, the *dried flower buds* of *Eugenia Aromatica*, a shrubby evergreen, introduced and cultivated in the East Indies. It has a strong aromatic odor of cloves and a pungent, spicy taste. The oil gradually becomes darker and thicker by age and exposure to the air. Its chief constituent is *eugenol*, which is also official, and of which it should contain not less than 82 per cent. by volume. The average dose is 3 min. (0.2 cc.).

EUGENOL—U.S.P.

(Eugenol; $C_{10}H_{12}O_2$.)

Eugenol is an aromatic phenol obtained from oil of cloves and other sources. It occurs as a thin, colorless or pale yellow liquid, highly refractive, and possessing a strongly aromatic odor of cloves and a pungent, spicy taste. It is practically insoluble in water, but freely soluble in alcohol. It may be used instead of oil of cloves, of which it is the chief constituent; it is also the chief constituent of oil of pimenta (allspice). The average dose is the same as of oil of cloves.

Physiologic Action.—Oil of cloves is just sufficiently irritant to the animal cell to be classed as an ideal antiseptic. It also possesses marked local analgesic properties. Internally administered, it is a powerful carminative and stimulant.

Therapeutics.—Because of its antiseptic and local analgesic properties, oil of cloves is one of the most valuable volatile oils. It

has long been a popular remedy for odontalgia (toothache). Oil of cloves, and its chief constituent, eugenol, are excellent agents to be employed as the liquid for making pastes when pulp-capping is indicated. A paste made of precipitated calcium phosphate or pure zinc oxid, in either of which 2 per cent. of thymol has been incorporated as the powder, and oil of cloves or eugenol as the liquid, is a valuable remedy for capping the pulp, or protecting this organ when it is involved from a deep-seated carious cavity. The author's newer product, Dentinoid, has largely replaced this paste for capping and protecting the dental pulp. (See Practical Therapeutics, p. 359.) Applied to a *canker sore* or in cases of *ulcerative stomatitis*, oil of cloves will prove to be one of the best healing agents. It is a counter-irritant, and as such will stimulate morbid processes.

OLEUM EUCALYPTI—U.S.P.

(Oil of Eucalyptus.)

Oil of eucalyptus is a colorless, or faintly yellowish volatile oil distilled from the *fresh leaves* of *Eucalyptus Globulus*, a tree which grows in the swampy regions of Australia and California. It has a characteristic, aromatic, somewhat camphoraceous odor and a pungent, spicy, and cooling taste. The chief constituent is *eucalyptol*, also official, and of which it should contain not less than 70 per cent. by volume. The average dose is 8 min. (0.5 cc.).

EUCALYPTOL—U.S.P.

(Eucalyptol; $C_{10}H_{18}O$.)

Eucalyptol is a colorless liquid, obtained from oil of eucalyptus and several other volatile oils, especially oil of cajuput. It is an organic oxid, probably identical with *cineol*, the chief constituent of oil of cajuput. It has a characteristic and distinctly camphoraceous odor and a pungent, spicy, and cooling taste. Almost insoluble in water, freely soluble in alcohol. The average dose is 5 min. (0.3 cc.).

Physiologic Action.—Locally applied, both oil of eucalyptus and eucalyptol are antiseptics, but have an irritant action. Commercial oil of eucalyptus is so irritating that it should not be employed in root-canal treatment. Many cases of pericementitis have been produced by commercial oil of eucalyptus having been sealed in the canals of teeth. Eucalyptol is also irritant, but not nearly so irritant as commercial oil of eucalyptus. When desired to be used in root-canal treatment, eucalyptol should be employed, or a refined specimen of the oil which is practically all eucalyptol.

Therapeutics.—Both oil of eucalyptus and eucalyptol have been employed in root-canal treatment. Like all of the volatile oils, they are practically worthless as remedies for correcting gangrenous pulp conditions, where they have been largely employed in the past. While eucalyptol is not nearly as irritant as the oil of eucalyptus, it is still too irritant, unless modified, to be sealed in a canal as an antiseptic remedy after the removal of a live pulp. Agents, such as oil of cloves or eugenol, having local analgesic as well as antiseptic properties, are far preferable. Oil of cajuput, containing cineol, a compound identical with eucalyptol, has a solvent action on gutta-percha, as has also eucalyptol, hence these agents find their greatest use in dental practice as remedies for moistening cavities to be temporarily sealed with gutta-percha, or root-canals previous to filling with gutta-percha. The author's formula for a remedy to be used for this purpose, as well as for sealing in the canals of all teeth where a mildly antiseptic dressing is indicated, is: Menthol 2 gr. (0.14 Gm.), thymol 3 gr. (0.2 Gm.), eucalyptol 1 dr. (4.0 cc.). This remedy is called *eucalyptol compound* (modified eucalyptol).

Oil of eucalyptus is an excellent remedy in chronic inflammation of mucous membranes, where it can be used as a spray combined with liquid petroleum in the proportion of 30–60 min. to the ounce (2–4 cc. to 30.0 cc.).

An infusion of eucalyptus leaves (5 per cent.) can be used as a mouth-wash or gargle in *stomatitis*.

As a stimulant expectorant eucalyptus is of great value in *colds* and *chronic bronchial catarrh*. A few drops of the oil of eucalyptus, or eucalyptol, can be dropped into hot water and the steam inhaled.

OLEUM MENTHÆ PIPERITÆ—U.S.P.

(Oil of Peppermint.)

Oil of peppermint is a colorless, or pale green volatile oil, distilled from the *fresh* or *partly dried leaves* and *flowering tops* of *Mentha piperita*, having the characteristic strong odor of the latter plant and a strong, aromatic, pungent taste, followed by a cool sensation upon inhalation. Its chief constituent is *menthol*, also official, and of which it should yield not less than 50 per cent. The average dose is 3 min. (0.2 cc.). There are two official preparations of oil of peppermint, both of which are useful in dental practice.

> Aqua Menthæ Piperitæ, Peppermint Water, used as a spray, as a vehicle for mouth-washes and local anesthetic solutions.
> Spiritus Menthæ Piperitæ, Spirit of Peppermint, is used also as a flavoring agent.

MENTHOL—U.S.P.

(Menthol; $C_{10}H_{20}O$.)

Menthol is a stearoptene, or secondary alcohol, obtained from the oil of peppermint and other mint oils by the process of congellation. It occurs in colorless, acicular, or prismatic crystals, having a strong and characteristic odor of peppermint, and a warm, aromatic taste, followed by a sensation of cold when air is inhaled. Sparingly soluble in water, freely in alcohol, ether, and chloroform. When triturated with about equal amounts of phenol, thymol, camphor, or chloral hydrate, it forms a liquid. The dose is 1 gr. (0.06 Gm.).

Physiologic Action.—Oil of peppermint and menthol are antiseptics, as well as possessing local analgesic properties to a marked degree. Like many other volatile oils of an aromatic character, oil of peppermint is a valuable carminative, stimulant, antifermentative, and antispasmodic.

Therapeutics.—Oil of peppermint, or menthol, is an ingredient of many remedies for obtunding sensitive dentin. A useful formula consists of menthol 20 gr. (1.33 Gm.), chloroform 2 fl. dr. (8.0 cc.), and ether 6 fl. dr. (24.0 cc.). The official water is an excellent vehicle for local anesthetic solutions, as well as for mouth-washes and sprays. Menthol is a constituent of many dental liniments for *neuralgia* and *pericementitis*. A good liniment for this purpose contains menthol 20 gr. (1.33 Gm.), chloroform 1½ fl. dr. (6.0 cc.), and tincture of aconite 6 fl. dr. (24.0 cc.).

Oil of peppermint, or menthol, is a constituent of many lotions and sprays for the local treatment of diseases of the *mouth*, *ear*, *nose*, and *throat*. Menthol is used extensively in *headache*, being rubbed on the forehead or inhaled from a metal container. In cases of *itching* of the skin or mucous membrane, menthol is a valuable remedy because of its analgesic properties. For this purpose it should be dissolved in a bland oil, like liquid petroleum, in the proportion of 30 gr. to the ounce (2.0 Gm.–30.0 cc.). It is also a constituent of *phenol compound* (see below).

OLEUM THYMI (Nonofficial)

(Oil of Thyme.)

Oil of thyme, formerly official, is a thin, colorless or pale yellow, sometimes red, volatile oil, distilled from *Thymus vulgaris*, a common shrub (garden thyme) which is indigenous to France, but cultivated

in the gardens of the United States. It has a strong odor of thyme, and a warm, pungent and, afterward, cooling taste. Its chief constituent is *thymol*, which is official, and of which the oil should contain not less than 20 per cent. by volume, of phenols. The average dose is 3 min. (0.2 cc.).

THYMOL—U.S.P.

(Thymol; $C_{10}H_{14}O$.)

Thymol is a phenol obtained from the oil of thyme. It occurs in large, colorless, translucent crystals, having a thyme-like odor and a pungent, aromatic taste, with a slight caustic effect upon the lips and mucous membranes. It is sparingly soluble (about 1,100 parts) in water and in less than its own weight in alcohol, ether, and chloroform, also readily soluble in fixed and volatile oils. When triturated with about equal quantities of phenol, menthol, camphor, or chloral hydrate, it liquefies.

Physiologic Action.—Thymol is a powerful antiseptic. It might almost be classed as a true disinfectant. It resembles phenol in its action, but being slowly absorbed is far less poisonous, yet vastly superior to it as an antiseptic. It possesses a peculiar, but favorable action on animal tissue. It undoubtedly has a preservative action on dead animal tissue. It is a stimulant though not an irritant or corrosive, and also has local analgesic properties.

Therapeutics.—Oil of thyme is not much used in dental practice except as a source from which thymol is obtained. Thymol has not been used to the extent which its importance merits, although it is rapidly gaining favor with modern therapeutists. It is a constituent of many remedies for root-canal treatment after live pulps have been removed. The author's *phenol compound* for this purpose contains menthol, 20 gr. (1.3 Gm.), thymol, 40 gr. (2.6 Gm.), and phenol (U.S.P.) 3 dr. (12.0 cc.). In order to make the remedy less irritating, camphor has been substituted for the thymol in the later formula. Dr. E. C. Kirk suggests using equal parts of thymol and phenol, called *thymophen*. Dr. H. Prinz uses thymol, camphor and phenol, called *thymocamphen*. A solution of a grain (0.06 Gm.) to the ounce of water (30.0 cc.), with a little alcohol used as a solvent, makes a good mouth-wash in the infectious forms of *stomatitis* and *pharyngitis* (Stevens). It is a constituent of the formerly official mouth-wash, liquor antisepticus (see p. 48); also the author's Desensitizing Paste (see p. 339).

IODUM—U.S.P.

(Iodin; I.)

Iodin is a nonmetallic element obtained chiefly from the ashes of sea-weeds (kelp). Fine specimens of such sea-weeds may be seen in the "submarine gardens" around Catalina Island, off the shore of Southern California. It occurs in heavy, bluish-black, friable crystals, having a metallic luster, a distinctive odor, and a sharp, acrid taste. On heating, it emits a violet-colored vapor. Iodin is sparingly soluble in water (5,000 parts), quite soluble in a solution of potassium iodid, and freely so in alcohol, ether, and chloroform. The average dose is $\frac{1}{12}$ gr. (0.005 Gm.).

The three official preparations are of value in dental practice. They are:

Liquor Iodi Compositus, U.S.P. Compound Solution of Iodin (Lugol's Solution; 5 per cent. of Iodin in a 10 per cent. solution of Potassium Iodid).
Tinctura Iodi, U.S.P., Tincture of Iodin (7 per cent.).
Unguentum Iodi, U.S.P., Iodin Ointment (4 per cent.).

IODOFORMUM—U.S.P.

(Iodoform; CHI_3.)

Iodoform is methyl tri-iodid, made by heating in a closed vessel iodin, alcohol, sodium hydrate, and water, wherein 3 atoms of hydrogen of the methane radicle (CH_4) are displaced by 3 of iodin. It occurs in small, lemon-yellow, hexagonal crystals, having a peculiar, very penetrating, and persistent odor, and an unpleasant, slightly sweetish, and iodin-like taste. It is very feebly soluble in water, soluble in about 60 parts of alcohol at 25°C. and freely soluble in ether, chloroform, and oils. It contains about 96 per cent. of iodin. The average dose is 4 gr. (0.25 Gm.). The official ointment of iodoform contains 10 per cent.

IODOLUM (Nonofficial)

(Iodol; Tetra-iodo-pyrrol; C_4I_4NH.)

Iodol, or tetra-iodo-pyrrol, is a derivative of the base pyrrol (C_4H_5N), obtained by the direct action of iodin upon the base in the presence of alcohol. It occurs as a yellowish, crystalline powder, without odor or taste, and contains about 90 per cent. of iodin. Iodol is practically insoluble in water, but freely soluble in alcohol, ether, and oils. It is used as a substitute for iodoform, and, though more expensive, has the decided advantage of being odorless.

THYMOLIS IODIDUM—U.S.P.

(Thymol Iodid; Di-thymol-di-iodid; Aristol; $C_{20}H_{24}O_2I_2$.)

Thymol iodid or aristol, is obtained by acting upon thymol in aqueous solution of sodium hydrate with iodin dissolved in a solution of potassium iodid. It occurs as a brownish-red powder, tasteless and almost odorless, and contains about 43 per cent. of iodin. It is nearly insoluble in water, but freely soluble in ether, chloroform, and oils. It is used as a substitute for iodoform, but is rather unstable, being decomposed by heat, light, acids, alkalies, alcohol, and corrosive sublimate. It is more expensive than iodoform and less effective.

EUROPHEN (Nonofficial)

(Di-isobutyl-cresol-iodid; $C_{22}H_{29}O_2I$.)

Europhen is obtained in exactly the same manner as that of preparing aristol, except that isobutyl-cresol is substituted for thymol. It occurs as a very bulky, yellow, amorphous powder, of an aromatic odor, and contains 28 per cent. of iodin. It is insoluble in water and glycerin, but freely soluble in alcohol, ether, and oils. In dental practice it is an excellent substitute for iodoform, and is far more stable than aristol.

NOSOPHEN (Nonofficial)

(Tetra-iodo-phenol-phthalein; $(C_6H_2I_2OH)_2C_8H_4O_2$.)

Nosophen is obtained by the action of iodin on a solution of phenol-phthalein. It is a pale yellow powder, without odor and taste, and contains 60 per cent. of iodin. It differs from iodoform in being an active antiseptic and in not yielding its iodin to the tissues.

Physiologic Actions.—Iodin can be classed as an ideal antiseptic in that it is just sufficiently irritant to the animal cell to cause stimulation, giving to the latter new life and energy whereby the animal cells attack and kill the invading germ, thus producing nature's method of disinfection.

When applied to the skin or mucous membrane it produces a yellowish-brown or black evanescent stain, and acts as an irritant or caustic, according to the strength of the solution used, and the frequency of the application. This discoloration can be readily removed by alcohol, solutions of potassium cyanid, sodium hyposulphite or ammonia. When tincture of iodin is frequently applied, vesication is produced, or perhaps sloughing. The blood-vessels

subjacent to the area to which it is applied are reflexly dilated, hence this drug is an efficient counterirritant.

When internally administered, it is rapidly absorbed in the form of iodids and soon reappears in all the secretions of the body; the bulk being eliminated, however, in the urine, also in the form of iodids. The continuous use is followed by a group of symptoms known as *iodism*. The more common manifestations of this condition are associated with the mucous membrane of the respiratory tract and with the skin, consisting of frontal headache, lacrimation, coryza, soreness of the throat, an increased flow of saliva, and sometimes an eruption on the skin. The amount of the drug required to produce iodism varies with different individuals. Iodoform differs somewhat in its action from iodin. Instead of being an irritant, it acts as a mild analgesic when applied to the mucous membrane and abraded surfaces, especially the latter. Iodoform and allied compounds have a favorable action on infected wounds, but how the result is produced is not well understood. It is known that as dry powders they possess little or no bactericidal action, yet when applied to raw surfaces they retard germ-growth, probably through the free iodin liberated, as they nearly all liberate their contained iodin when in contact with the fluids of the tissues.

Therapeutics.—Applied to infected wounds, iodin is an efficient antiseptic. The tincture of iodin or the compound solution may be employed in full strength, or diluted, to *sluggish ulcers* and *abscess cavities*, or in cases of *local arsenical poisoning*. For the latter condition, a creamy paste made of europhen and liquid petroleum can be applied to the affected part on sterile gauze or cotton. Where pain is a prominent symptom, as in cases of lacerated *gum tissue* and *exposed process after extraction*, othoform (40 parts) can be mixed with europhen (60 parts) and made into a paste with liquid petroleum. Applied in the same manner it will stop the pain like magic. This remedy is called *euroform paste*. For the protection and treatment of *wounds involving bone* a stimulating and antiseptic ointment may be used. This preparation should be sufficiently stiff so as to remain in place without the use of gauze or cotton as the carrying medium. The author's *Analgentum* answers this purpose. It contains 20 per cent. of thymol iodid and 5 per cent. of orthoform, combined with a stiff sterilized petrolatum vehicle.

As a counterirritant iodin is a valuable drug, as the blood-vessels subjacent to the area to which it is applied are reflexly dilated. The tincture of iodin in full strength should not be used as a dental counterirritant because of its local destructive action on the mucous

membrane. For this purpose the compound solution should be employed or the tincture of iodin modified. A favorite combination is tincture of aconite 2 parts, tincture of iodin and chloroform, of each, 1 part. The chloroform volatilizes rapidly when applied and the irritant action of the iodin is modified by the aconite, a local sedative. This remedy is especially valuable in cases of pericementitis, where a mild but persistent counterirritant effect is desired. It is also used to sterilize the mucous membrane before injecting local anesthetic solutions.

Iodin will stain the tooth-structure and there is no necessity for using the drug within the tooth, as other remedies are at hand which will accomplish all that can be expected of iodin without discoloration.

Iodin is useful as an antiseptic and stimulant in the treatment of *periodontoclasia* (*pyorrhea alveolaris*) and will be referred to again in Practical Therapeutics (p. 521). Iodoform has little use in dental therapeutics except iodoform gauze, which is used in packing surgical wounds, abscess cavities, etc.

In regions where there is little or no available iodin in the soil and water, various types of *thyroid involvement* are common. This is true of the inhabitants of the belt lying along the Great Lakes, and such thyroid involvements are far less in people living along or nearer the oceans, where the spray is drifted inland by the winds. Accordingly girls frequently develop goiter in the Great Lakes district; and the administration of a few grains of iodin every six months seems to be sufficient to maintain the normal function of the thyroid gland, preventing an increase in the size of the goiter and in many cases a marked decrease is shown.

BETANAPHTHOL—U.S.P.

(Betanaphthol; $C_{10}H_7OH$.)

Betanaphthol is a monatomic phenol occurring in coal-tar, but usually prepared artificially from naphthalene. It occurs in white, shining crystalline scales, or as a yellowish-white crystalline powder, having a faint, phenol-like odor and a sharp, pungent, but not persistent taste. It is sparingly soluble in water, freely in alcohol, ether, and chloroform. It should be kept in dark, amber-colored, well-stoppered bottles. The average dose is 4 gr. (0.25 Gm.).

Physiologic Action.—Betanaphthol is antiseptic, antifermentative, deodorant, and may also be considered a disinfectant. Its action closely resembles that of phenol, but is less poisonous.

When applied locally to the skin or mucous membrane, betanaphthol is readily absorbed, and, in concentrated solutions, it is irritating to the tissues to which it is applied. Toxic symptoms may result from its absorption by the skin; these also resemble those of phenol.

Therapeutics.—Betanaphthol has been recommended as a constituent of root-canal filling materials. It will not corrode metal instruments, therefore solutions can be used for immersing instruments during the surgical treatment of *pyorrhea* and other operations. The solubility of the drug is increased in boiling water. A suitable solution can be prepared in hot water and used when sufficiently cooled. Some of the drug will be precipitated as the solution cools, but as it is not irritating in this strength solution it does not matter materially. The saturated aqueous solution may also be employed to irrigate wounds and as a constituent of mouth-washes.

In medicine it is used as a parasiticide in certain diseases of the skin, as *scabies* (itch) and *ring-worm*. It is best to employ it in the form of an ointment in the strength of a dram (4.0 Gm.) to the ounce (30.0 Gm.), for in this way it is not irritating.

RESORCINOL—U.S.P.

(Resorcin; $C_6H_4(OH)_2$.)

Resorcin is a diatomic phenol occurring in the form of colorless or faintly reddish, needle-shaped crystals, or rhombic plates, having a faint peculiar odor and a sweetish, and afterward pungent taste. It is freely soluble in water, alcohol, ether, and glycerin. It darkens when exposed to light and air, and should be kept in dark amber-colored, well-stoppered bottles. The average dose is 2 gr. (0.125 Gm.).

Physiologic Action.—Resorcin acts very much like phenol, but is less poisonous and less irritant. It has marked antiseptic properties, and being practically nonirritating is a useful drug in the treatment of many pathologic conditions about the mouth and throat.

Therapeutics.—Resorcin has been used for keeping instruments sterile during surgical operations, but its continued use will affect the metal. In a 2 to 5 per cent. solution it is efficacious as a mouth-wash or gargle in the treatment of certain subacute and chronic conditions of the mucous membrane, as in *ulcerative stomatitis*, *pharyngitis*, *laryngitis*, *whooping-cough*, and *diphtheria*. An ointment of resorcin (5 per cent.) is an excellent remedy to apply to *sloughing wounds*, *foul ulcers*, and *syphilitic ulcers*. A dusting powder, con-

sisting of 1 part resorcin and 10 parts boric acid, can be used with much benefit in cases of *suppurating wounds*. As a remedy for dandruff of the scalp, Stevens recommends the following: Resorcin 1½ dr. (6.0 Gm.), castor oil ♏ xx–xxx (1.2–2.0 cc.), bay-rum 3½ fl. oz. (105.0 cc.).

CARBO LIGNI—U.S.P.
(Wood Charcoal)

Carbon was formerly official in the following forms: *Animal charcoal, purified animal charcoal*, and *wood charcoal*. The latter is the only form recognized in the U.S.P. IX and X. Animal charcoal, or bone-black, is prepared by burning bones in closed iron cylinders. It is composed of carbon and certain earthy salts (calcium carbonate and phosphate). Purified animal charcoal is bone-black from which the above-mentioned salts have been removed by hydrochloric acid. Wood charcoal is prepared by burning soft wood without access to air; it is very finely powdered. It occurs as a black, odorless and tasteless powder, free from gritty matter.

Charcoal is mentioned here because of its deodorizing power. It has the peculiar property of absorbing many times its own volume of gases and vapors. It is not used much in dental practice, except in the laboratory for refining metals. When well ignited it will deoxidize the most obdurate metals. Animal charcoal is largely used by chemists for decolorizing many solutions and for removing coloring matter from alkaloids. It is also employed as a filtering medium for purifying drinking-water. White wood ash was formerly used for cleaning teeth by the laity. Because of the grittiness of the particles, it should not be so employed. It is sometimes internally given as an absorbent in *flatulent dyspepsia*. Here it is best administered in cachets—thin discs of dough of the shape of a soup-plate and varying from ½ to 1½ inches in diameter. When two of them are placed together with their concave sides toward each other, they form a recepticle in which such powders as carbon are conveniently dispensed. Before carbon is thus administered it is best to subject it to heat thereby driving off the accumulated and occluded assortment of drug store gases and odors.

CALENDULA (Nonofficial)
(Marigold)

Calendula is the *dried ligulate florets* of *Calendula officinalis*, an annual plant, indigenous to Southern Europe and the Levant, fre-

quently cultivated as a garden ornament. It contains a bitter principle, *calendulin*, and a trace of volatile oil. The average dose is 5 gr. (0.3 Gm.). The tincture is the only preparation employed:

Tinctura Calendulæ, U.S.P. VIII (20 per cent.). *Dose*, 15 min. (1.0 cc.).

Physiologic Action and Therapeutics.—Calendula has a stimulating action upon mucous membranes, and has been used chiefly for its local influence. It acts similar to arnica, and is employed for practically the same conditions. The tincture may be applied to *recent wounds, lacerated gums, open sores, etc.* It hastens the healing of wounds, and materially aids union of coapted surfaces by *first intention.* It causes a *scar*, or *cicatrix*, to form without contraction of tissue, and is especially useful in *severe burns.*

ARNICA (Nonofficial)

Arnica is the *dried flower-heads* of *Arnica montana*, a perennial plant, growing in temperate regions of Europe, Asia, and America. It contains a glucosid, *arnicin*, and a volatile oil. The dose is about 15 gr. (1.0 Gm.). Both the drug and the tincture were formerly official:

Tinctura Arnicæ, U.S.P. *Average dose*, 15 min. (1.0 cc.).

Physiologic Action and Therapeutics.—The action of arnica closely resembles that of calendula. The tincture has been extensively used as a stimulating application in *sprains* and *bruises.* Its antiseptic power is doubtless due to its irritant effect upon animal cells, and to the alcohol which the tincture contains.

MYRRHA—U.S.P.
(Myrrh.)

Myrrh is a *gum-resin* obtained from *commiphora myrrha*, a small tree growing in Eastern Africa and Arabia. It occurs in the form of brownish-red, irregularly-shaped tears, having an agreeable aromatic odor and a bitter, acrid taste. The dose is about 5 gr. (0.3 Gm.). Its official preparation and the one formerly official into which it enters are:

Tinctura Myrrhæ, U.S.P. *Average dose*, 15 min. (1.0 cc.).
Pilulæ Rhei Compositæ, U.S.P. IX. (Aloes, ½ gr. 0.1 Gm.; Rhubarb 2 gr.–0.13 Gm.; Myrrh, 1 gr.–0.06 Gm.). *Average dose*, 2 pills.

Physiologic Action and Therapeutics.—Myrrh is a stimulant to mucous membranes and acts as an antiseptic and astringent. The

tincture, diluted with water or with a weak solution of borax or potassium chlorate, has been extensively used as a local application in *ptyalism, ulcerative stomatitis,* and *spongy gums.* Water added to the tincture forms an emulsion on account of the resinous constituent of myrrh.

OXYGENIUM—U.S.P.

(Oxygen; O.)

Oxygen, for the first time, was recognized by the U.S.P. IX. It is a colorless, odorless and tasteless gas; practically insoluble in water, more readily soluble in alcohol. It contains not less than 95 per cent. by volume of O (16); and, for convenience, it is usually compressed in metal cylinders. The U.S.P. IX and X has adopted oxygen (16) as the *standard* for atomic weights, in accordance with the report of the International Committee on Atomic Weights (now Committee on Chemical Elements). Formerly hydrogen (1.01) was taken as the standard. Oxygen is correct as it weighs exactly 16, while hydrogen was only approximately correct since it weighs 1.01. The gas is used extensively in *nitrous oxid, ether* and *chloroform narcosis,* as well as in *bronchitis, anemia, phthisis,* and the later stages of *acute pneumonia.* It is given by inhalation by means of a specially devised apparatus. It is also used in dentistry as a bleaching agent (see Practical Therapeutics, p. 489). For bleaching purposes the oxygen is obtained from compounds containing it, such as sodium dioxid and hydrogen dioxid. For experimental purposes, it may be obtained by carefully heating potassium chlorate in a suitable retort. If the potassium chlorate be previously mixed with about one-fourth of its weight of manganese dioxid, it gives up the whole of its oxygen at a temperature considerably below the melting-point of the salt, and at a greatly accelerated rate.

Ozone is an allotropic form of oxygen, and may be prepared from the latter electrically. It occurs in the air, especially after an electrical storm. It is no doubt an important factor in the antiseptic processes of nature, and has been used to some extent as a therapeutic agent in the treatment of *periodontoclasia,* and other pathologic conditions; but its practical application, as yet, has not been fully demonstrated.

PHENOL—U.S.P.

(Phenol; Carbolic Acid; C_6H_5OH.)

Phenol is obtained from coal-tar by fractional distillation. It is also prepared synthetically. When pure, it occurs in the form of

colorless, needle-shaped crystals, of a characteristic odor and of an acrid, burning taste. On exposure to damp air it deliquesces, and the solution exposed to light gradually acquires a reddish tint. It is soluble in about 15 parts of water, at 25°C., and freely in alcohol, glycerin, ether, chloroform, and oils. It should be kept in dark amber-colored bottles, well-stoppered. Although it was official up to 1900 under the name Acidum Carbolicum, chemically considered, it is not an acid, but an alcohol of the benzene group. The average dose is 1 gr. (0.06 Gm.).

All of the official preparations are valuable in dental practice. They are:

Phenol Liquefactum, U.S.P. (contains 88 per cent. of absolute Phenol and 12 per cent. of Water).
Unguentum Phenolis, U.S.P. Ointment of Phenol (2¼ per cent.).
Glyceritum Phenolis, U.S.P. Glycerite of Phenol (20 per cent.).

Physiologic Action.—Phenol is a disinfectant, as it destroys microorganisms. Some spore-bearing forms, however, are very resistant to its action. In weak solutions (2 per cent.) it acts as an antiseptic. Phenol is also a caustic and local analgesic. When applied to the skin or mucous membrane it blanches the surface and causes a burning sensation, which is soon followed by numbness. Later the part becomes red, then brown, and ultimately desquamation takes place. Its action is much more severe on mucous membranes, and it should be used about the mouth with caution. Phenol coagulates albumin, therefore its caustic action is limited, and does not extend deeply into the tissues. Absorption of the drug occurs readily from the skin, mucous membranes, and wounds. Its prolonged use, even in dilute solutions (2–5 per cent.) may cause gangrene of the parts.

Poisoning by Phenol.—Poisoning by phenol may occur either from the drug being taken internally or from its external application. It is a poison used more widely for suicidal purposes, perhaps, than any other. Because of this fact, a law is in force in many States of the Union preventing its sale to the laity in broken packages in stronger solutions than 10 per cent., the dilution being made with alcohol and glycerin. Unbroken, sealed pound containers of phenol may be sold in full strength.

Toxic doses render the patient rapidly unconscious, or the patient may drop dead in from twelve to fifteen minutes after taking it from

respiratory paralysis. Butler states that 8.5 Gm. have caused the death of an adult in fifteen minutes. One and one-half grams have caused the death of a child in a short time. If the dose has not been sufficient to cause respiratory paralysis in so short a time, the symptoms are those of gastroenteritis—intense pain, violent vomiting of white slimy mucus, and purging. The pupils are contracted, stertorous breathing appears, with cold, clammy skin, pinched face, anxious expression, and a rapid, feeble pulse, finally followed by unconsciousness and death from failure of respiration. The characteristic phenomena are the odor on the breath, the destruction of the buccal mucous membrane, and the smoky urine. In poisoning from the external use of phenol the initial symptoms generally are headache, vertigo, pallor, muscular weakness, and discoloration of the urine.

Treatment of Poisoning.—When the poison has been taken by the mouth there are two drugs especially indicated in the treatment —alcohol and magnesium sulphate (Epsom salt). The alcohol neutralizes the caustic action, and the soluble sulphate forms with the phenol the innocuous phenol sulphonate. Two or three ounces (60.0 –90.0 cc.) of diluted alcohol should be poured into the stomach through a tube, followed by frequent washing out of the stomach with warm water containing magnesium sulphate. Warm demulcent drinks are useful in allaying the irritation. To increase the efficiency of the function of the heart and respiration, strychnin sulphate and atropin sulphate are indicated. For the relief of pain, opium or its alkaloids may be administered. When phenol is accidentally or otherwise applied to the skin or mucous membrane, its caustic action can be prevented by immediately applying alcohol to the part.

Therapeutics.—Phenol, possessing as it does the properties of an antiseptic, disinfectant, cauterant, and local analgesic, is one of the most useful drugs in dental practice. As a disinfectant, the true value of the drug has been overestimated. Its great affinity for albumin, which it quickly and firmly coagulates, prevents any penetration beyond the superficial layer of tissue to which it is applied. At best, then, it is but a surface disinfectant. A 1 per cent. solution can be employed for immersing the points of instruments while scaling the teeth in *pyorrheal* treatment. Probably the only objection to this solution is the odor, and yet patients have been taught that any solution possessing the odor of phenol is cleansing, so even this objection loses its weight.

The drug can be added to local anesthetic solutions for the purpose of keeping the latter sterile. Two to 3 gr. (0.13–0.19 Gm.) to the ounce (30.0 cc.) is sufficient to prevent the growth of bacteria, and

in this strength it can be injected into the tissue without any appreciable coagulation of the albumin.

Its local analgesic property makes it a valuable remedy for desensitizing dentin, to apply to an aching pulp in the early stages of *pulpitis*, and also as a root-canal dressing after the removal of the pulp tissue by either the anesthetization or devitalization method. It has been used for devitalizing the pulp tissue in deciduous teeth. Its action here is slow and unsatisfactory. As a stimulating agent for cauterizing *sinuses* associated with *dento-alveolar abscesses*, it has long been used with success where there is no root or bone complication. In cases of painful *canker sores* it is a most useful remedy. Applied full strength to the ulcerated or denuded spot, it arrests the septic process, and the coagulum formed serves as a protection to the exposed nerve-endings.

CRESOL—U.S.P.

(Cresol; Tricresol; $C_6H_4\begin{cases}CH_3\\ \cdot\\ OH\end{cases}$)

Cresol, formerly commercially called *tricresol*, is a refined mixture of three isomeric cresols obtained from coal-tar, freed from phenol, hydrocarbons, and water. It occurs as a colorless or straw-colored refractive liquid, having a phenol-like odor and a burning, caustic taste. It is soluble in 50 parts of water at 25°C., and miscible with alcohol and glycerin in all propotions. Cresol is sometimes erroneously called crecylic acid. It is not an acid, but is methyl phenol, the three isomeric forms being known chemically as ortho-, meta-, and paracresol. On exposure to light, cresol turns to a yellowish-brown color. It should be kept in dark amber-colored bottles, well-stoppered. The dose is 1 minim (0.06 cc.). The official *Liquor Cresolis Compositus* (Compound Solution of Cresol) is practically identical with the commercial preparation known as *lysol*. It is a linseed-oil-soap solution of cresol, 50 per cent. in strength.

Lysol (nonofficial) is a cresol preparation made by dissolving in fat, and subsequently saponifying with alcohol that portion of tar-oil which boils between 347° and 392°F. (190° and 200°C.). It contains 50 per cent. of comparatively pure cresols. It is a brown, oily liquid, and mixes with water to form a clear, saponaceous, frothy liquid.

Physiologic Action.—Cresol is one of the newer preparations, and its action is almost identical with that of phenol. Some authorities

claim, however, that cresol is more toxic to bacteria than is phenol, but that it is less toxic to the animal cell than is the latter. In this respect it approaches what might be termed an *ideal disinfectant*—an agent which will kill the bacteria without acting deleteriously upon the animal cell; but cresol is too toxic to the animal cell to be so considered. Cresol is a caustic, though somewhat milder in action than phenol, and it possesses marked local analgesic properties.

Therapeutics.—Cresol is a disinfectant. It may be used in dental practice with equal results in almost every condition where phenol is indicated. In some instances it is greatly superior to the latter drug. Its odor may be considered an objection, but its valuable properties far outweigh this slight objection. As a local analgesic or anodyne for root-canal dressings it is valuable, and can be used with success as a cauterizing and stimulating agent in uncomplicated *sinuses* associated with *dento-alveolar abscesses*. It can be dissolved in glycerin or alcohol, with both of which it is miscible in all proportions, and the solution added to mouth-washes, sprays, and other antiseptic remedies. A 1:500 solution may be used as a vehicle in which to dissolve local anesthetic agents, as cocain hydrochlorid. Such solutions remain free from bacteria, and are not irritant to the tissues in which they are injected. For preservative reasons cresol (0.4 per cent.) is added to prepared local anesthetic solutions and to biologic products. It surpasses phenol for this purpose and requires a somewhat less amount for sterility. It is a constituent of the author's *formocresol* remedy which is an absolute *specific* for *gangrenous pulp conditions*.

The compound solution of cresol and lysol are used in from 1 to 2 per cent. solutions in surgical work, as in the treatment of *periodontoclasia*.

CREOSOTUM—U.S.P.

(Creosote.)

Creosote is a mixture of phenols and phenol derivatives, chiefly guaiacol and creosol, obtained during the distillation of wood-tar, preferably of that derived from the beech. It is an almost colorless, or a faintly yellow, oily liquid, having a penetrating, smoky odor, and a burning, caustic taste. It is slightly soluble in water, soluble in all proportions in alcohol, ether, chloroform, and oils. It seems rather difficult to obtain pure beech-wood creosote. Much of the creosote on the market is impure phenol (carbolic acid). Tests for the purity of the drug can be made as follows: 1. Mix equal quantities of the suspected specimen and collodion in a clean, dry test-

tube; the formation of a coagulum will indicate the presence of phenol. 2. Mix intimately equal volumes of the suspected liquid and glycerin, then add one or more volumes of water; the absence of turbidity indicates an impure specimen of creosote. The average dose is 4 min. (0.25 cc.). The former official preparation, Aqua Creosoti, is not much used in dentistry. As stated above, the chief constituents of creosote are guaiacol and creosol; the former is official.

GUAIACOL—U.S.P.

Guaiacol is a phenol derivative obtained by fractional distillation from creosote. It is a colorless, oily liquid, having a rather unpleasant aromatic odor and taste. It is sparingly soluble in water, freely so in alcohol and ether. The average dose is 8 min. (0.5 cc.).

Physiologic Action.—Like all members of the phenol groups, creosote is an antiseptic, disinfectant, caustic and local analgesic. Its action closely resembles that of phenol, but it is less irritant and toxic.

Therapeutics.—Creosote is employed in dental practice chiefly as a disinfectant and local analgesic. It is probably used more because of its analgesic property than any other. Three or four minims (0.18–0.24 cc.) placed on a blank tablet, a piece of loaf sugar, or candy form a valuable remedy for preventing *nausea in taking impressions*. This should be held in the mouth until the vehicle is dissolved. Creosote mixed with an equal volume of liquor formaldehyd, to which a small quantity of alcohol (20 min. to the ounce —1.3–30.0 cc.) is added, makes an excellent remedy for the treatment of *gangrenous pulp conditions*. Equal volumes of creosote and tincture of iodin have long been employed as a local analgesic and stimulant in *apical pericementitis*. Care must be taken to prevent the remedy from staining the dentin of the crown of the tooth, causing discoloration. Creosote is largely used as a *toothache* remedy by the laity. Guaiacol is not much used in dentistry, but is used in medicine in *pulmonary tuberculosis* as a substitute for creosote.

FORMALDEHYDUM (Nonofficial)

(Formaldehyd; Formic Aldehyd; CH_2O.)

Formaldehyd is a colorless gas, having a very pungent odor, obtained by the partial oxidation of methyl alcohol (wood-alcohol). The Pharmacopeia recognizes a 37 per cent. aqueous solution of the gas under the name Liquor Formaldehydi—Solution of Formaldehyd.

Various solutions of the gas are on the market, commercially called *formalin, formol, etc.* The gas in solution readily undergoes polymerization, whereby a solid form is obtained, now also recognized by the U.S.P. as **Paraformaldehydum** (**Paraformaldehyd**) and called synonymously *trioxymethylen* or *paraform* (CH_2O_3). This is a white crystalline powder, which yields formaldehyd on heating, or at body temperature. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action.—Formaldehyd is one of the best disinfectants. Stevens states that a 1 per cent. solution of liquor formaldehyd kills pure cultures of pathogenic bacteria in an hour. It is a powerful deodorizer, readily uniting with hydrogen sulphid, mercaptan, ptomains, ammonia, and fetid ammonia bases to form inodorous compounds.

The gas is intensely irritating; when inhaled it causes severe hyperemia and even inflammation of the mucous membrane of the entire respiratory tract. Concentrated solutions will produce a slough almost as readily as arsenic trioxid.

The antidote for formaldehyd poisoning is ammonia, with which it forms the harmless hexamethylenamin (urotropin).

Therapeutics.—Because of the power formaldehyd has of uniting with the intermediate and end-products of *pulp decomposition*, forming with them nonpoisonous substances and converting the *gases* into *liquids* and *solids*, it is a most essential constituent of *gangrenous pulp* remedies. Its irritating action can be controlled by mixing the official liquor formaldehyd with cresol, phenol, or creosote. The author's *formocresol* remedy is equal volumes of cresol and liquor formaldehyd. When used, this remedy should always be hermetically sealed within the tooth with a nonyielding sealing material, such as the dental cements.

A 10 per cent. solution of liquor formaldehyd, to which 2 per cent. of borax or sodium carbonate is added, makes an excellent sterilizing fluid for small instruments. The alkaline salt (borax or sodium carbonate) prevents the formaldehyd from attacking the metal. In weak solutions (1 : 1,000 to 1 : 500) it may be added to mouth-washes and sprays. Apparatus are on the market for using paraform for sterilizing instruments. Probably the only objection to this method is the liability of the gas escaping in the office. Some individuals are peculiarly susceptible to formaldehyd, having an idiosyncrasy for the drug. The author has known of a few such cases among dentists, where even a slight exposure to the gas would cause red blotches on the face and hands, resulting in desquamation (scaling). The condition has been erroneously diagnosed as *psoriasis*, a chronic inflam-

matory disease of the skin characterized by the development of reddish patches covered with whitish scales. Individuals thus affected should avoid exposure in any manner to formaldehyd. Fortunately these cases are rare, for the drug is a valuable one in dental practice, if properly used.

In medicine formaldehyd is extensively employed as a *surface disinfectant for rooms* containing the germs of contagious diseases. Both the aqueous solutions and the solid paraform are used for this purpose. The process is known as terminal disinfection.

Incompatibilities.—Formaldehyd is incompatible with ammonia, alkalies, tannic acid, and mineral salts.

HEXAMETHYLENAMINA—U.S.P.

(Hexamethylenamin; Urotropin.)

Hexamethylenamin, or urotropin, is the product formed by the action of formaldehyd on ammonia. It is not used in dental practice, but mentioned here because of its formation within the tubular structure of the dentin when formaldehyd gas is sealed within a gangrenous root canal. The average dose is 4 gr. (0.25 Gm.). The drug is especially indicated in *suppurative diseases* of the genito-urinary tract; and is also frequently given in severe *sore throat*, especially in cases of infection by the *streptococcus* germ.

LIQUOR HYDROGENII DIOXIDI—U.S.P.

(Solution of Hydrogen Dioxid; H_2O_2.)

Hydrogen dioxid is a very unstable compound, prepared by the action of mineral acids (usually sulphuric acid) on barium dioxid. The official aqueous solution should contain, when freshly prepared, about 3 per cent. by weight of absolute hydrogen dioxid, which corresponds to about 10 volumes of available oxygen. Previous to the U.S.P. IX the solution was classified as a "water." It is now properly classified as a "liquor." The solution is a colorless liquid, without odor, slightly acidulous to the taste, and producing a peculiar sensation and a soapy froth in the mouth. It is liable to deteriorate with age or by exposure to heat or protracted agitation. The dose is 1 fl. dr. (4.0 cc.), well diluted with water.

There is an unofficial ethereal solution of hydrogen dioxid on the market which contains 25 per cent. of the drug.

Physiologic Action.—When hydrogen dioxid is applied to mucous membranes it decomposes into water and oxygen, the latter being given off in large quantities. The oxygen thus liberated is in the

nascent state and readily oxidizes surrounding substances. Applied to suppurating wounds or abraded surfaces, effervescence follows from the free oxygen. This effervescence is not necessarily an indication of the presence of infection or pus, as hydrogen dioxid will produce effervescence when in contact with blood. Hydrogen dioxid, because of the liberation of nascent oxygen, destroys healthy granulations in healing wounds and should, therefore, be employed with caution, if used at all. It may cause sudden death when injected hypodermically or intravenously by the formation of gaseous emboli in a blood-vessel.

Therapeutics.—As a cleansing agent and disinfectant, hydrogen dioxid has been extensively applied to diseased surfaces, such as *canker sores* and other *ulcers*, *pyorrheal pockets*, *sinuses*, etc. It is used extensively by the laity for cuts and bruises. It has little value here as a therapeutic agent, except that the effervescence caused by its action on the blood may mechanically remove dirt or other foreign bodies. In diluted solution it has been much used as an antiseptic remedy in many diseases of the *mouth*, *throat*, and *nose*. The drug may be used as a gargle or spray, or applied with a syringe or a swab. The value of hydrogen dioxid as a therapeutic agent depends upon the readiness with which it liberates oxygen when it is brought in contact with abraded tissues and with the fluids of the body. It should, therefore, be used with great caution in *all practically closed sinuses* and on *granulating surfaces*. While the drug has its use in dental practice, its real value has been overestimated, and much harm has resulted from its injudicious employment. It is used for moistening pumice in prophylactic work; the only objection to its employment here is that the agent causes effervescence and hides the field of operation. As a cleansing and whitening agent for the teeth, it is also used by the laity, but its continued use as a mouth-wash is likely to affect deleteriously the tooth-structure, on account of the uncombined sulphuric acid it contains. This latter agent has been considered necessary to preserve the solution, and is added by manufacturers. Glycerin in small quantities will preserve the solution equally as well, and its use here has no objection. As a bleaching agent it is of great value. The preparation mostly used for bleaching tooth-structure is the 25 per cent. ethereal solution.

SODII PERBORAS (Nonofficial)

(Sodium Perborate; $NaBO_3.4H_2O$.)

Sodium perborate was official in U.S.P. IX, and occurs as white, crystalline granules or as a white powder; odorless, and having a

saline taste. The drug is stable in cool and dry air, but is decomposed in warm or moist air, with the evolution of oxygen. Therefore, it should be preserved in well-closed containers, in a cool place. It is freely soluble in water; and the aqueous solution of the salt is alkaline in reaction. Sodium perborate contains not less than 9 per cent. of available oxygen. The average dose is 1 gr. (0.06 Gm.).

Physiologic Action and Therapeutics.—Sodium perborate is an antiseptic, deodorant and bactericide. In the presence of moisture or heat it readily gives up its available oxygen. In general, it is used in place of hydrogen dioxid, over which it has the distinct advantage of yielding an alkaline solution. The drug is used in the treatment of *wounds*, *purulent sores*, *ulcers*, etc. By some authorities it is considered a specific for *Vincent's infection*. It is used both as a dusting powder and in a 2 per cent. solution.

POTASSII PERMANGANAS—U.S.P.

(Potassium Permanganate; $KMnO_4$.)

Potassium permanganate occurs in the form of slender, dark-purple prisms, odorless, and of a sweetish, astringent taste. It is soluble in 13.5 parts of water at 25°C., and is decomposed by alcohol and hydrogen dioxid. It should be kept in glass-stoppered bottles, protected from light, and care should be taken not to bring it in contact with organic or readily oxidizable substances. The average dose is 1 gr. (0.06 Gm.).

Physiologic Action.—In the presence of organic matter potassium permanganate quickly yields its oxygen; hence it is a good disinfectant and deodorant. Its usefulness, however, is limited, for when its oxygen is given up it is rendered inert.

Therapeutics.—Its readiness to part with oxygen renders it of great value as a deodorant, and in dilute solutions, 1–5 gr. (0.06–0.32 Gm.) to 1 ounce (30.0 cc.) of water, it is a useful remedy in *thrush*, *foul ulcers*, *putrid sore throat*, *syphilitic chancre*, and *cancer of the tongue*.

It is employed in surgical practice for disinfecting the hands, and should be followed with a saturated solution of oxalic acid to remove the stain. Its disadvantage for use in the mouth is its tendency to discolor the enamel of the teeth. This is only a surface and, therefore, temporary discoloration.

Incompatibilities.—Potassium permanganate is incompatible with organic substances, alcohol, hydrogen dioxid and formalin. With the latter solution it forms a vigorous reaction.

CHINOSOL (Nonofficial)

Chinosol occurs as a yellowish, crystalline powder, having a saffron-like odor and a burning taste; soluble in water, but insoluble in alcohol and ether. The aqueous solution has an acid reaction. The average dose is 5 gr. (0.3 Gm.).

Physiologic Action and Therapeutics.—Chinosol is a powerful antiseptic. Cook and Mawhinney have spoken highly of the drug as a pus-destroyer, recommending its free use in from 1 to 10 per cent. solutions in *foul, chronic abscesses* and all other violent suppurations. Experimental evidence thus far has proven chinosol to be nontoxic. As a disinfectant it is weaker than phenol, and much weaker than mercuric chlorid; though as an antiseptic it is considered stronger than and preferable to either of these drugs. It has been found to exert a restraining (antiseptic) influence on germs in solutions containing 1 part to 10,000. The drug does not coagulate albumin nor injure the mucous membranes or tissues. Therefore, its solution in various strengths is used to advantage in treating many conditions in both medicine and dentistry. As an antiseptic wash the average strength of solution is 1:1,000. In gargles the strength may be increased to 1:250. The drug is claimed to possess marked analgesic power and to be an efficient deodorant.

HYDRARGYRI CHLORIDUM CORROSIVUM—U.S.P.

(Mercuric Chlorid; Mercury Bichlorid; Mercury Perchlorid; $HgCl_2$.)

While **mercuric chlorid** will be discussed with the class of alteratives under Mercury and its Compounds (see p. 216), the class of disinfectants would indeed be incomplete without the mention of this important and valuable drug.

Mercuric chlorid is the most popular of all the disinfectants for surgical work. The drug is cheap, soluble, and attacks bacteria and their by-products with energy. However, there are three principal objections to its employment: It is extremely poisonous; it attacks metallic instruments detrimentally; and it readily acts upon albuminous matter, rendering the drug inert. Stevens claims this last objection may be eliminated by adding to its solution a weak acid (tartaric or citric acid).

MERCUROCHROME (Nonofficial)

(Mercurochrome-220 Soluble.)

Mercurochrome–220 soluble is the disodium salt of 2:7 dibromo–4-Hydroxymercurifluorescein, containing 23 to 24 per cent. of mer-

cury. It occurs as iridescent, green scales or granules; odorless; permanent in the air. It is freely soluble in water; soluble in 65 parts of alcohol; insoluble in chloroform or ether. The aqueous solution (1:10) of mercurochrome-220 soluble is of a deep cherry-red color; on dilution with water it becomes fluorescent. The aqueous solution is stable in the air, does not precipitate proteins and does not respond to the usual tests for mercury ions. Solutions are self-sterilizing and need not be boiled. They should be made from the drug itself, not the tablets.

Physiologic Action and Therapeutics.—Mercurochrome-220 soluble is a strong and rapidly acting disinfectant. It penetrates the tissues readily in that it does not precipitate proteins. When tested with animals, especially the rabbit, its toxicity is rather high. No systemic effects have been observed following its local application in the human. The drug appears to be particularly active against organisms of the colon groups. Its use in staphylococcus and streptococcus infection is often times without effect, though in some cases good results follow. By some it has been overrated as an antiseptic solution in dental therapeutics. There is nothing to justify its use over other more pleasant and less staining solutions in *prophylaxis* and the treatment of *periodontoclasia.*

Incompatibles.—The drug is incompatible with acids, with the salts of most alkaloids and with local anesthetics. The aqueous solution stains the skin red. If desired the discoloration may be removed by washing the part with a solution of sodium hypochlorite (solution of chlorinated soda).

Heat is a valuable disinfectant, and without doubt is the most reliable for sterilizing instruments. All known pathogenic bacteria and their spores are destroyed by heat. The best method of sterilizing operative and surgical instruments is to immerse them in boiling water for from 2 to 15 minutes, according to the demands of the case. Many practical "sterilizers" are on the market for this purpose (see p. 323).

CHLORAMINA AND DICHLORAMINA—U.S.P.

(Chloramin-T and Dichloramin-T.)

Early in the recent World War surgeons found that the customary methods of treating wounds were inadequate for those caused by modern weapons. This was not only on account of the number and extent of lacerations, but also because of the inevitable infection. As a result of research prompted by these new conditions, Dakin, of

the Herter Laboratory, New York, discovered that a weak *neutral solution of sodium hypochlorite* could be used effectively without injury to the tissues, both in preventing infection or in doing away with it even if it had become extensive. Accordingly Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, New York, and Dr. George W. Crile, of Cleveland, Ohio, and others, began using this latest method for treating *infected wounds*. The wound was first thoroughly irrigated with Dakin's solution and then exposed to light from electric lamps placed in paste-board cones on metal hoods suspended from an adjustable frame. The amount of light and the proximity of the lamps to the wound was governed by the comfort of the patient. When coagulated serum developed, Crile suggested a hot pack for half an hour with Wright's *hypertonic solution.*

A hypertonic solution is one whose osmotic tension exceeds that of the blood-serum. The formulæ for Dakin's and Wright's solution are here given:

Dakin's Solution.

Dry sodium carbonate	200 Gm.
Chlorinated lime	140 Gm.
Tap water	10 L.

Mix and filter through cotton, and add 40 Gm. boric acid.

Wright's Solution.

Sodium chlorid	3 parts.
Sodium citrate	1 part.
Water	96 parts.

This method of treating wounds became known as the Carrel-Dakin method, and while it was a valuable advance in surgery, its use was quite impractical except in hospitals with proper equipment and a special personnel. Dakin's original solution is rather difficult and troublesome to make. It is unstable, necessitating continual manufacture, and large quantities were required. A twenty-four hour service of a surgical nurse was essential to success, as was also frequent bacterial examinations of the wound. These difficulties Dakin sought to overcome and the result of his further researches developed some new chlorin compounds, which possess the good qualities of neutral hypochlorites and are sufficiently stable to be marketed. Thus these new compounds of chlorin are readily available and an elaborate technic for their successful use is not necessary. Dakin has named these two new compounds for *wound disinfection* **Chloramin-T** and **Dichloramin-T** respectively, while a third

new chlorin compound for *the disinfection of water* he has named **Halazone.**

Chloramin-T, called also **Chlorazene**—names shortened for convenience in use from toluene-parasodiumsulphonchloramin, is a white, crystalline solid, without odor, and containing 12.6 per cent. of chlorin. Readily soluble in water, its solutions have a bitter taste and are comparatively stable, no appreciable decomposition taking place upon exposure to ordinary room light and temperature. Chloramin-T gives up its chlorin less rapidly than does an equimolecular solution of neutral sodium hypochlorite. Its antiseptic power is claimed to be about four times greater than that of the hypochlorites; it is more efficient in the presence of blood than is neutral sodium hypochlorite, has a prolonged antiseptic activity, and is less irritating than the hypochlorites. All antiseptics of the chlorin group are promptly decomposed by the secretions when used in septic conditions.

Physiologic Action and Therapeutics.—Chloramin-T is a non-irritating antiseptic and is used in the treatment of many pathologic conditions in dental practice. A 2 per cent. solution may be employed for the treatment of all *septic wounds*. It is used in *persistent empyema, in abscesses* and for establishing and washing out *fistulas*. As an irrigating solution in the treatment of *periodontoclasia* it is useful; as it is also in *Vincent's infection*. In practice, it is advisable to keep a 2 per cent. in stock and dilute this, if necessary, with water or physiologic salt solution. A 2 per cent. solution is slightly hypotonic, and when an approximate isotonic solution is desired, physiologic salt solution should always be used as a diluent. The solution corrodes metals and should not be used for the sterilization of instruments.

Dakin and Dunham[1] recommend impregnating gauze with chloramin-T, 5 per cent. being adequate for all purposes. The drug is well adapted for use in this manner, which is true of but few substances of high antiseptic value. The gauze should not be moistened before use. It can be used dry for lightly packing and, if necessary, subsequently moistened when in position. Impregnated gauze is of most value in recent wounds to check progress of infection. Squibb's have prepared a surgical paste of chloramin-T, after Daufrense, which contains the drug combined in sodium stearate. This paste is sufficiently firm to remain in place and yet fluid enough to be molded over the part to be medicated. It is designed to maintain wounds in an antiseptic condition which have

[1] Handbook of Antiseptics.

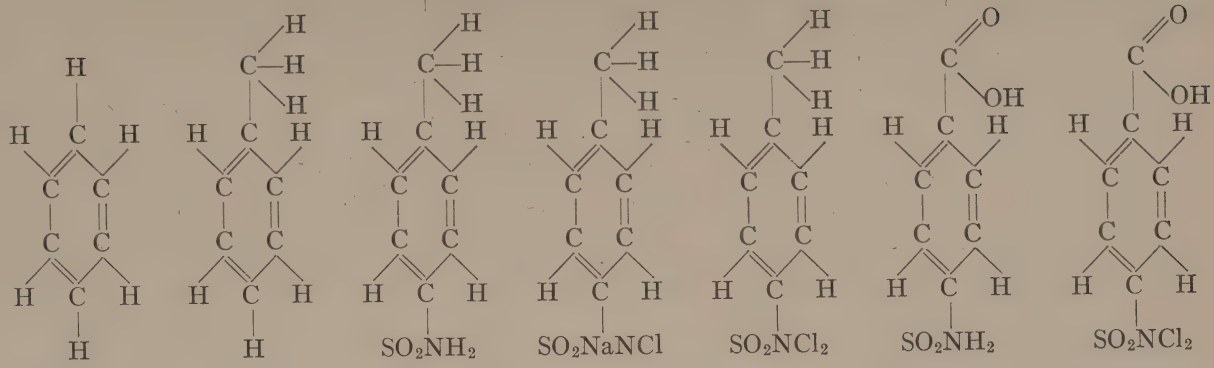
already been disinfected, or to sterilize wounds which are only slightly infected. It does not sterilize severely infected wounds. Chloramin-T paste, therefore, should be used only on wounds yielding small quantities of secretion, and which have little or no necrotic tissue.

Dichloramin-T.—A name also shortened in use from toluene-parasulphondichloramin, is a slightly yellowish, crystalline solid, of a somewhat sweetish taste, and having a pungent odor resembling chlorin. It contains 29 per cent. of combined chlorin; and differs from chloramin-T in having the sodium atom replaced by an atom of chlorin. Solid dichloramin-T is comparatively stable under ordinary conditions, but its solutions are unstable. It is but slightly soluble in water, but more freely soluble in certain organic solvents; especially so in specially treated eucalyptol and treated paraffin oils. Like certain other compounds containing chlorin, it should be protected from light and kept in black bottles.

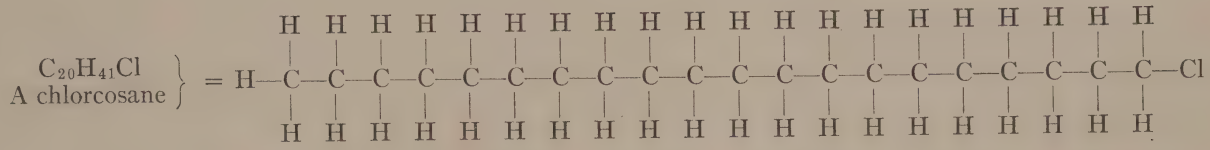
Physiologic Action and Therapeutics.—Dichloramin-T is a very active and powerful disinfectant, and is best used in the oily solutions; thus prolonging its antiseptic action by more slowly liberating its chlorin content. In oily solution it has a great advantage over the other chlorin antiseptics in that it may safely be used in higher concentration; its action of longer duration, and still absolutely nonirritating. Dakin and Dunham[1] recommends for surgical cases a 6.5 to 10 per cent. solution in treated eucalyptol and paraffin oil. The oily solution may be sprayed upon *wounded surfaces* or poured into accessible parts of *deep wounds*, after a careful surgical preparation of the wound at the primary dressing, and excision of all foci of infection and of devitalized tissues. Major E. K. Dunham has developed a new oil-solvent for dichloramin-T, called **Chlorcosane.** This solvent is prepared by an extensive chlorination of paraffin, white wax, in a molten state, at high temperature. This produces a heavy, clear, almost tasteless, nonirritant and nontoxic oil, which will dissolve about 10 per cent. of dichloramin-T, and is the solvent used at the present time. To prepare a solution in chlorcosane, warm about one-fourth the required volume of chlorcosane to about 80°C. with the dichloramin-T, stirring until dissolved, then add the remaining solvent, cold, thus completing the solution and, at the same time, reducing the temperature. If necessary, this may be filtered through a folded filter paper. The solution of the antiseptic is applied by a grooved director, cotton swab or glass atomizer. This method of treating *wounds* is now widely used by the U. S. Army, the U. S. Navy, and by surgeons in civil practice. In

[1] Handbook of Antiseptics.

Comparative Structural Formulæ of Chlorinated Antiseptics (Squibb's)



Benzene (Benzol) | Toluene | Toluene para-sulphonamid | Toluene para-sodiumsulphon-chloramin (Chloramin-T) | Toluene para-sulphondichlor-amin (Dichloramin-T) | Parasulphon-amidobenzoic acid | Parasulphondi-chloramino-benzoic acid (Halazone)



$C_{20}H_{41}Cl$ A chlorcosane

Other chlorcosanes = $C_{21}H_{43}Cl$ $C_{21}H_{42}Cl_2$ $C_{25}H_{49}Cl_3$ $C_{27}H_{55}Cl$, etc., etc.

ordinary wounds the application may be made once in 24 hours and the dressings very light. For *gangrenous* or for *foul wounds* a more frequent application should be made, as the active chlorin here is consumed more rapidly.

Dichloramin-T solutions may be used to advantage in dentistry for many of the pathologic conditions mentioned under the therapeutics of chloramin-T, such as *periodontoclasia*, *Vincent's* and other *oral infections*, and the *sterilization of root canals*. Its several advantages may be summarized as follows:

1. When applied to tissues its disinfectant power is of longer duration. The oily solvent, chlorcosane, acts as a control, slowly releasing the chlorin, thus less frequent applications are required.
2. Oily, emollient, nonirritating properties.
3. Contains a higher percentage of combined chlorin (29 per cent.) and its solutions may be used in higher concentration.
4. More rapid action on infecting organisms.
5. Convenience of application.

In preparing and using Dichloramin-T solutions, it should be remembered that not only is the agent insoluble in water, but the presence of water causes its decomposition with evolution of hydrochloric acid. The drug is also decomposed by most of the chemic antiseptics used in dentistry, such as alcohol, phenol, cresol, formalin, formocresol, iodin, mercury bichlorid, and others.

Halazone is a short term for parasulphondichloraminobenzoic acid. It occurs as a white powder, sparingly soluble in water and in chloroform, and insoluble in petroleum. It dissolves readily in glacial acetic acid, crystallizing in stout prisms which melt at 213°C. Compared with most members of the chlorin group, it is remarkably stable; and is best kept and used in tablet form. Its use is solely for the purpose of sterilizing small individual quantities of water.

ASTRINGENTS, STYPTICS, AND HEMOSTATICS

Astringents are agents which produce contraction and condensation of tissue. **Styptics** and **hemostatics** apply to agents that arrest hemorrhage. When the agent is applied locally it is called a styptic; when administered internally it is called a hemostatic. Many of the styptic and hemostatic agents control hemorrhage by virtue of their astringent property, for which reason these classes of remedies are discussed here conjointly. Astringent agents exert their influence most markedly when applied upon raw surfaces and mucous membranes. Many of them also have the property of diminishing or ar-

resting glandular secretion. This result is produced more by the direct action of the agent upon the secreting cell than it is by the constriction of the blood-vessels of the part. Cook, in his experiments upon dogs, has shown that mouth-washes which contain astringent agents, notably zinc chlorid, arrest the secretion of ptyalin for a considerable number of hours after the solution is employed.

Most of the astringents are also irritants; especially is this true of some of the metallic salts, the action of which is more irritant and caustic than astringent. This is largely due to the liberation of an acid by the union of the metal with the albumin of the cells.

Astringents may be conveniently divided into two classes, *vegetable* and *mineral*. The efficacy of those of vegetable origin depends upon the tannic acid which they contain. It should be remembered that among the mineral astringents, bismuth subnitrate, zinc oxid, and lead acetate have more of a sedative than an irritant action. The vegetable astringents of importance are:

Tannic acid.	Ergot.
Gallic Acid.	Krameria.
Hematoxylon.	Hamamelis.

Hydrastis.

Hemostatics of animal origin are:

Thyroid. Fibrin Ferments and Thromboplastic Substances.

The important mineral astringents are:

Alum.	Zinc Oxid.
Lead Acetate.	Zinc Iodid.
Copper Sulphate.	Zinc Chlorid.
Zinc Sulphate.	Calcium Chlorid.
Zinc Phenolsulphonate.	Bismuth Subnitrate.

Silver Compounds.

ACIDUM TANNICUM—U.S.P.

(Tannic Acid; Tannin; $HC_{14}H_9O_9$.)

Tannic acid is the active constituent of all vegetable astringents. Its chief source is from *nutgall*. It occurs in the form of a light-yellowish, amorphous powder, odorless, and of a strongly astringent taste. Soluble in about 0.34 part of water and in 0.23 part of alcohol; also soluble in about 1 part of glycerin with the aid of moderate heat. The average dose is 8 gr. (0.5 Gm.).

All of the official preparations are valuable astringent remedies. They are:

Glyceritum Acidi Tannici, Glycerite of Tannic Acid (20 per cent.).
Unguentum Acidi Tannici, Ointment of Tannic Acid (20 per cent.).
Trochisci Acidi Tannici, Troches of Tannic Acid (1 gr.–0.06 Gm. in each).
Collodium Stypticum, Styptic Collodion (20 per cent.), U.S.P. VIII.

Physiologic Action.—Tannic acid, especially when applied to raw surfaces, coagulates the albumin of the superficial cells, causing condensation of the tissue, which is evidenced by the sensation of puckering. On mucous membranes it acts in a similar manner, combining with the proteids of the glandular cells, thus drying up the secretion. It also paralyzes the sensory nerve-endings and blunts the sense of taste. It may be considered a styptic, as it coagulates the albumin of the blood and checks hemorrhage. When administered internally, tannic acid is changed in the intestine into gallic acid, and in this form a certain amount is absorbed and eliminated in the urine; it also acts as a hemostatic.

Therapeutics.—Tannic acid is a valuable astringent drug. It may be applied locally in the form of the glycerite in cases of *spongy gums*, or the glycerite may be added to mouth-washes to the extent of from 2 to 5 per cent., thus giving to the solution an astringent property. For years the glycerite was applied to the pulp tissue after devitalization for the purpose of toughening the tissue and aiding in its subsequent removal from the canals of teeth, but its liability to discolor the tooth-structure when so used constitutes a serious objection to its employment (see p. 379).

A solution of from ½ to 1 per cent. is a useful remedy to be used as a spray or gargle in cases of *stomatitis*, *laryngitis*, and *pharyngitis*. Many dentists are troubled with *hyperidrosis of the hands*. Lotions containing tannic acid are often beneficial in this condition. Dusting-powders, as well as lotions, are also used in *hyperidrosis of the feet*.

Styptic collodion serves as a protection to *lacerated* or *incised wounds*. Troches of tannic acid may be dissolved in the mouth with benefit in cases of *sore throat*.

Incompatibility.—Tannic acid is incompatible with alkaloids, gelatin, lime-water, the salts of iron, silver, lead, and copper. When

potassium chlorate is triturated with tannic acid or organic drugs containing the latter, the mixture is liable to explode.

ACIDUM GALLICUM (Nonofficial)

(Gallic Acid; $HC_7H_5O_5 + H_2O$.)

Gallic acid is prepared generally from *tannic acid*. It occurs as white or pale fawn-colored, silky needles, odorless, having an astringent or slightly acidulous taste. It is soluble in 87 parts of water, in 4.6 parts of alcohol, and in 10 parts of glycerin at 25°C. The average dose is 15 gr. (1.0 Gm.), given in powders or capsules.

Physiologic Action.—Gallic acid resembles tannic acid when administered internally; but, applied locally, it is a very feeble astringent, as it does not coagulate albumin and hence does not influence the tissue like tannic acid.

Therapeutics.—About the only indication for gallic acid in dental practice is in cases of *hemorrhage following extraction*. Here it would be employed purely as a hemostatic, and its action as such is questionable, except in *intestinal hemorrhage*.

KRAMERIA—U.S.P.

(Krameria; Rhatany.)

Krameria is the *dried root* of *Krameria triandra*, a low shrub growing in sandy localities in the mountains of Bolivia and Peru. Tannic acid is the chief constituent. The following preparations, which with the drug itself were official in the U.S.P. VIII, are of value in dentistry. The drug and the tincture are again official in U.S.P. X:

Extractum Krameriæ. *Average dose*, 5 gr. (0.3 Gm.).
Fluidextractum Krameriæ. *Average dose*, 10 min. (0.6 cc.).
Syrupus Krameriæ. *Average dose*, 1 fl. dr. (4.0 cc.).
Tinctura Krameriæ. *Average dose*, ½ fl. dr. (2.0 cc.).
Trochisci Krameriæ. *Average dose*, 2 troches (each contains 1 gr.–0.06 Gm. of the extract).

Phyiologic Action.—The action of krameria is identical with that of its chief constituent, tannic acid.

Therapeutics.—The astringency of the drug is due entirely to the tannic acid which it contains in large amount. It has no special advantage over tannic acid. The various preparations of krameria, especially the tincture, may be added to mouth-washes and gargles to be used in cases of *rubber sore mouth*, *spongy gums*, *ptyalism*, and *pharyngitis*. The troches are also useful in *sore throat*.

HAMAMELIS (Nonofficial)

(Witch-hazel.)

Hamamelis was formerly official as the *bark* and *dried leaves* of *Hamamelis Virginiana*, a shrub growing in the damp woods of North America. It contains a volatile oil, a small amount of tannic acid, and a bitter principle. There are no official preparations in the U.S.P. X. The following however is useful:

> Aqua Hamamelidis, U.S.P. IX; distilled extract of Witch-hazel. *Average dose*, 2 fl. dr. (8.0 cc.).

Physiologic Action.—The action of hamamelis is that of an astringent, due largely to the tannic acid it contains. Besides its astringent property, the drug is credited with having a marked sedative effect when topically applied.

Therapeutics.—Preparations of hamamelis are useful household remedies. As a topical application after *shaving*, and for *sprains* and *bruises* hamamelis water has long enjoyed a popular reputation. Diluted with water, alcohol, or glycerin (1 part to 3), the distilled extract may be used as a spray in *inflamed* and *spongy gums*, in *pharyngitis*, and applied to the nasal mucous membrane after the removal of *polypi*. A five per cent. decoction makes an excellent vehicle for a phenol or potassium chlorate gargle.

Hamamelis water has been recommended, diluted one-half with distilled water, as a vehicle for local anesthetic solutions. It should not be so employed, as the tannic acid will act upon the alkaloidal salt (usually cocain hydrochlorid) and precipitate the alkaloid.

HÆMATOXYLON (Nonofficial)

(Logwood.)

Hematoxylon is the *heart-wood* of *Hæmatoxylon campechianum*, a rather small tree growing along the shores of the Gulf of Campeachy and in certain parts of South America. Besides tannic acid it contains a crystalline coloring principle, *hematoxylin*. The extract as well as the drug itself was official in the U.S.P. VIII. The drug has no dental use except as a staining agent for tissues in microscopic study, for which purpose it is extensively employed, and may be found among the "reagents" of Part II, U.S.P. IX. **Hematein,** a product of the oxidation of hematoxylon, is classed among the reagents in the U.S.P. X.

ERGOTA—U.S.P.

(Ergot; Ergot of Rye.)

Ergot is the sclerotium of *Claviceps purpurea*, a parasitic fungus, which replaces the *grain of rye, Secale cereale.* Ergot is obtained chiefly from the rye growing in Russia, Spain, and Germany. The following preparation is official:

Fluidextractum Ergotæ, U.S.P. *Average dose*, 30 min. (2.0 cc.).
Extractum Ergotæ, U.S.P. IX. *Average dose*, 4 gr. (0.25 Gm.).

Physiologic Action.—Ergot has no local action. The drug must be taken internally to produce its effects. When it enters the circulation it acts directly upon the muscular coats of the vessels, causing constriction of the arterioles, with an increase in arterial pressure. The involuntary muscles throughout the body appear to be influenced by ergot; the voluntary muscles are unaffected.

Therapeutics.—Ergot is used in dentistry for its hemostatic property. In cases of known *hemorrhagic diathesis* (*hemophilia*), it is well to administer the drug a few hours previous to the extraction of teeth or other operations involving hemorrhage. The fluid extract is the most reliable preparation and may be given in doses of ½–1 fl. dr. (2.0–4.0 cc.).

Ergot should not be given when the hemorrhage proceeds from a large vessel, because here the muscular contraction could not close the vessel, and the increased arterial pressure, occasioned by the drug, would naturally increase the flow of blood.

The drug should not be given to *pregnant* women, because of the contraction it produces on the unstriped muscle of the uterus. Ergot is the one drug relied upon to prevent *postpartum hemorrhage* during and following labor in confinement cases.

HYDRASTIS—U.S.P.

(Golden Seal.)

Hydrastis is the *dried rhizome* and roots of *Hydrastis canadensis*, a perennial herb growing in the woods of North America. One of the chief constituents is *hydrastin*, which was official under the title *Hydrastina.* Hydrastin hydrochlorid, Hydrastinæ Hydrochloridum, was also official; as was also the hydrochlorid of an alkaloid obtained by the oxidation of hydrastin, called Hydrastinin Hydrochlorid, Hydrastininæ Hydrochloridum. These have been deleted in the U.S.P. X, as were also the tincture and glycerite. Other constituents of hydrastis are *berberin* and *canadin.*

The one official preparation of hydrastis is:

Fluidextractum Hydrastis, U.S.P. *Average dose*, 30 min. (2.0 cc.).
Tinctura Hydrastis, U.S.P. IX. *Average dose*, 1 dr. (4.0 cc.).
Glyceritum Hydrastis, U.S.P. IX. Externally.

Physiologic Action and Therapeutics.—The action of hydrastis is due almost entirely to the presence of the alkaloid, *hydrastin*, which it contains. Applied locally, it appears to have a stimulating influence upon the *oral mucous membrane*. The glycerite may be added to mouth-washes (5 per cent.) and used in sluggish conditions of the mucous membranes, as in *chronic catarrh, etc.* The drug also has astringent and antiseptic properties. The fluid extract applied to *indolent ulcers* stimulates the condition to a healthy activity. Internally administered it acts as a stomachic and is a constituent of many bitter tonics.

Incompatibles.—These are the same as those of other alkaloids.

SUPRARENALUM SICCUM (Nonofficial)

(Desiccated Suprarenal Glands; Suprarenal Extract.)

This product is neither a vegetable nor mineral astringent, but is considered here because it belongs to this group. The drug was official in U.S.P. IX. It is the *suprarenal gland* of the animals which are used for food by man (sheep, ox, etc.), freed from fat, cleaned, dried, and powdered; and containing not less than 0.4 per cent. nor more than 0.6 per cent. of *epinephrin*, the active principle of the suprarenal gland. It occurs as a light, yellowish-brown powder, having a slight, characteristic odor; partially soluble in water. The average dose is 4 gr. (0.25 Gm.).

The active principle has been separated by different men and variously named *epinephrin* (Abel), *suprarenin* (Von Furth), *adrenalin* (Takamine and Aldrich). According to the best authorities, the last-named, adrenalin, represents more fully the active properties of the gland. It occurs as a white, crystalline substance. It dissolves with difficulty in cold water; but dissolves readily in acids, forming salts. A solution of adrenalin chlorid is on the market, as are other liquids and solids for styptic and hemostatic purposes. Epinephrin is produced synthetically and is on the market in various forms under the name "L.-Suprarenin Synthetic."

Physiologic Action and Therapeutics.—Suprarenal gland, or solutions of its active principle, act locally on a variety of structures, probably by stimulating the sympathetic nerve terminals. Its most

important action is the constriction of blood-vessels, with the usual high rise of blood pressure. The drug is used in dentistry largely for its hemostatic properties. It should be remembered that the solution of epinephrin (adrenalin, suprarenin) will better prevent hemorrhage if used before operating than it will check hemorrhage after it has begun. Braun, Fischer and others recommend its use for the vasoconstrictor action to intensify and prolong the anesthetic effect of local anesthetics by retarding the circulation in the affected part and thus hindering the dilution of the anesthetic agent by too rapid absorption into the general blood stream. Solutions of adrenalin chlorid have been recommended as the vehicle for dissolving cocain hydrochlorid in the removal of the dental pulp by pressure anesthesia. Its use here, however, is unwarranted and objectionable (see Practical Therapeutics, p. 373).

The dilute aqueous solutions are rather unstable, the deterioration being accompanied by a reddish or brownish discoloration. The drug can be obtained alone or combined with other drugs, in tablet form. The powder is stable.

THYROIDEUM—U.S.P.

(Thyroid; Thyroideum Siccum U.S.P. IX.)

This product is the *thyroid gland* of animals which are used for food by man, freed from fat, cleaned, dried, and powdered. It must contain not less than 0.17 per cent. nor more than 0.23 per cent. of iodin in thyroid combination. One part represents approximately 5 parts of the fresh gland. It is a yellowish, amorphous powder, partially soluble in water. Average dose, 1½ gr. (0.1 Gm.). The product is not much used in dentistry, its general properties being alterative, hemostatic, and antifat.

FIBRIN FERMENTS AND THROMBOPLASTIC SUBSTANCES

(Nonofficial)

The clotting of blood has been shown to be due to the action of the fibrin ferment (thrombin) on the fibrinogen of the blood. The fibrin ferment of thrombin exists in the blood in the form of its forerunner (prothrombin) which is acted on by the calcium salts and converted into thrombin. Another factor, however, is necessary for blood does not clot spontaneously in the vessels, though calcium salts are present in sufficient amount. This other factor may be furnished by the breaking down of the blood cells or blood platelets or by the pieces of tissue that are cut or badly injured. It has been

variously designated by different investigators as "zymoplastic substance," "thrombokinase" and as thromboplastic "substance" or "thromboplastin." Howell believes that the reason that blood does not coagulate within the vessels is that the prothrombin exists there in combination with an inhibiting substance which prevents it from acting. This writer believes that when blood is shed or flows over injured tissue the thromboplastin derived from the blood cells, blood platelets or tissue cells combines with, or neutralizes, this inhibiting substance, liberating the prothrombin from combination with the latter. The prothrombin thus liberated and activated by the calcium salts, is converted into thrombin and converts the fibrinogen of the plasma into fibrin, causing coagulation to set in. Thromboplastin or thromboplastic substance contains the phosphated cephalin and it is known that the facilitating influence of thromboplastin on coagulation is due to the action of the cephalin—an unstable product. On the basis here explained several of the Pharmaceutical Manufactures have prepared hemostatic products, under various names, which are on the market.

Physiologic Action and Therapeutics.—Preparations containing thromboplastin, such as Hemagulen, etc. are useful in the treatment of hemorrhages, especially hemorrhages from *oozing surfaces, scar tissue* and in *nose bleed.* The preparations are useful in dental therapeutics wherever the checking of hemorrhage is desired, and have largely displaced the older remedies used for this purpose. In *hemorrhage following extraction* the tooth socket may be loosely packed with cotton or narrow gauze moistened with the solution. These preparations act as physiologic hemostatics by supplying to the escaping blood one of the necessary constituents for the production of a clot, for they contain the thrombo plastic substance of fresh brain tissue, suspended in physiologic saline solution. They require standardization by physiologic test.

ALUMEN—U.S.P.

(Alum.)

The United States Pharmacopeia now recognizes two kinds of **alum—ammonium alum** and **potassium alum.** The ammonium or potassium is combined chemically with aluminum in the form of a sulphate, and is what is known in chemistry as a double sulphate. Both occur in large, colorless, octahedral crystals, odorless, but having a sweetish and strongly astringent taste. Soluble in water and in warm glycerin, insoluble in alcohol. The ammonium alum is

somewhat less soluble in water than is the potassium alum. The average dose is 8 gr. (0.5 Gm.). As an emetic it may be given in much larger doses—1–2 dr. (4.0–8.0 Gm.). The dried or burnt alum is also official under the title Alumen Exsiccatum, U.S.P.

Physiologic Action.—Alum is a powerful astringent when applied to the broken skin or mucous membranes. It acts by coagulating the albumin of the superficial cells, thus causing condensation of the tissues. With the blood it forms a firm coagulum, and tends to arrest hemorrhage. When applied to the unbroken skin, it has a tendency to thicken and harden it.

Therapeutics.—In edentulous mouths alum may be used to toughen the mucous membrane. A solution of from 5 to 10 gr. (0.3–0.6 Gm.) to the ounce (30.0 cc.) is a useful remedy in cases of *rubber sore mouth, subacute and chronic pharyngitis* and *laryngitis*, especially where there is a viscid mucous secretion. It has a destructive action on the tooth-structure, hence its prolonged use in the mouth is contraindicated, except in edentulous mouths. It may be used as a styptic to arrest *hemorrhage from small wounds*. A large smooth crystal may be moistened and applied to the face after *shaving*, as the alum thickens and toughens the unbroken skin and also tends to arrest any *small hemorrhages* which may follow the operation. Dried alum may be employed as a mild caustic for *indolent ulcers* and for destroying *exuberant granulations*, as are often seen covering the fragment of a broken tooth-root a few days after an unsuccessful attempt at extraction.

Lotions of alum and dilute alcohol are sometimes employed in *hyperidrosis of the hands and feet.*

Incompatibles.—Alum is incompatible with alkalies, alkaline carbonates, lead acetate, mercury, iron salts, and tannic acid.

PLUMBI ACETAS—U.S.P.

(Lead Acetate; Sugar of Lead; $Pb(C_2H_3O_2)_2 + 3H_2O$.)

Lead acetate occurs in colorless, shining, transparent, heavy prismatic crystals or crystalline masses, having a faintly acetous odor and a sweetish, astringent, afterward metallic taste. It is soluble in 1.4 parts of water and in 38 parts of alcohol at 25°C. The average dose is 1 gr. (0.065 Gm.).

Physiologic Action.—Metallic lead is practically inert, and the tissues take kindly to it. A clean lead bullet may become encysted in the tissues. Lead acetate has valuable therapeutic properties. Applied in solution to denuded or highly inflamed surfaces, its action

is both astringent and sedative. In the mouth it acts immediately, coagulating the mucus and producing a sweet, styptic taste. When taken internally and absorbed, the lead enters as a constituent part into the protoplasm of the cells, and is exceedingly slow in being eliminated. *Lead poisoning* may result from the internal administration, but the cases fortunately are rare, for the acetate is an emetic and the emesis produced prevents toxic effects of the drug.

Therapeutics.—Lead acetate is not much employed in dental practice. Its sedative as well as its astringent properties make it a useful drug to be applied to *acute inflammatory conditions* of all mucous membranes. In cases of *inflammation* following the removal of foreign substances from the eye, a solution of lead acetate, 1–2 gr. (0.065–0.13 Gm.), to the ounce (30.0 cc.) of distilled water makes an excellent collyrium. Should the solution be turbid or milky, it indicates a trace of lead oxid. The smallest amount (1 min.–0.05 cc.) of dilute acetic acid will clear the solution.

CUPRI SULPHAS—U.S.P.

(Copper Sulphate; Blue Vitriol; $CuSO_4 + 5H_2O$.)

Copper sulphate occurs in large, transparent, deep-blue crystals, odorless, and of a nauseous metallic taste. It is soluble in about 2.5 parts of water at 25°C., and almost insoluble in alcohol. The average dose as an astringent is ½ gr. (0.032 Gm.); as an emetic, 4 gr. (0.25 Gm.).

Physiologic Action.—The mode of action of copper sulphate depends largely upon the strength of the solution employed. Dilute solutions act upon mucous membranes and raw surfaces as an astringent. In concentrated solutions or applied in the crystal or powdered form, it acts as a mild caustic. Internally administered in large doses, it produces emesis by its direct irritant action on the stomach.

Therapeutics.—Copper sulphate is a useful drug in cases of *canker sores*, *ulcerative stomatitis*, and other *indolent ulcers*. Light applications of the solid crystal produce a stimulant effect upon the sluggish cells.

It is a prompt and powerful emetic, but considered too irritant to the stomach for ordinary use.

Bevan and Brophy report good results with copper sulphate in the treatment of *actinomycosis* occurring in man. They begin with about ¼ gr. (0.016 Gm.) given three times a day, gradually increas-

ing the dose to 1 gr. (0.065 Gm.). In addition to the internal administration of the drug, irrigations of a 1 per cent. solution are also employed.

CUPRI OXIDUM (Nonofficial)

(Black Copper Oxid; CuO.)

Copper oxid occurs as a heavy dark-brown powder; insoluble in water. This product has been modified by Ames, and is used as the powder for the copper phosphate cement, a material extensively employed in filling cavities in children's teeth. This cement is claimed to possess marked antiseptic properties as well as serving the function of a temporary filling material. It has one distinct advantage in that it may be applied directly against the gums or other tissues, which take kindly to it.

ZINCI SULPHAS—U.S.P.

(Zinc Sulphate; White Vitriol; $ZnSO_4 + 7H_2O$.)

Zinc sulphate occurs in colorless, transparent crystals, or granular crystalline powder, odorless, and of an astringent metallic taste. It is efflorescent in dry air. Soluble in less than its own weight (0.53 part) in water, in about 2.5 parts glycerin at 25°C.; insoluble in alcohol. It is rarely given internally except as an emetic, when the average dose is 15 gr. (1.0 Gm.).

Physiologic Action.—Zinc sulphate acts as an astringent, styptic, emetic, and antiseptic. In weak solutions it is astringent and antiseptic; in strong solutions it acts as an irritant or caustic, tending to arrest slight hemorrhage when applied externally, and, when administered internally, producing emesis.

Therapeutics.—Weak solutions of zinc sulphate may be applied to raw surfaces and to mucous membranes whenever a slight astringent effect is desired. A solution of from ½–2 gr. (0.03–0.125 Gm.) to the ounce (30.0 cc.) is a valuable collyrium in *simple conjunctivitis*. A 1 per. cent solution is also useful in *ulcerative stomatitis*, *cancrum oris*, and as a gargle in *enlarged tonsils* and *sore throat*.

As an emetic it is employed in *narcotic poisoning*, 10–30 gr. (0.6–2.0 Gm.) dissolved in water, being given and repeated in fifteen to twenty minutes, if necessary.

Incompatibles.—Zinc sulphate is incompatible with alkalies, alkaline carbonates, vegetable astringents, lead acetate, silver nitrate, and lime-water.

ZINCI PHENOLSULPHONAS (Nonofficial)

(Zinc Phenolsulphonate; Zinc Sulphocarbolate; $Zn(C_6H_4(OH)SO_3)_2$.)

Zinc phenolsulphonate, also commonly, though erroneously, called zinc sulphocarbolate, was official in U.S.P. IX. It occurs in colorless, transparent prisms, or tabular crystals, odorless, and having an astringent, metallic taste; on exposure to air and light it effloresces and may acquire a pink tint. It is freely soluble in water and alcohol. The aqueous solution is acid to litmus. It is rarely given internally; the average dose is 2 gr. (0.125 Gm.).

Physiologic Action.—Zinc phenolsulphonate is an astringent and antiseptic. and produces a stimulant effect upon mucous membranes. It acts similarly to other zinc salts, but the contained phenol radical adds to its antiseptic power.

Therapeutics.—This salt has but recently been employed in dental practice. Whitslar suggests the use of a 10 per cent. solution in cinnamon water as a stimulating antiseptic following the surgery of *periodontoclasia*. ½ dr. (2.0 Gm.) added to 8 oz. (240.0 cc.) of liquor antisepticus makes a valuable astringent mouth-wash to be used in *stomatitis* and *sore throat.*

ZINCI OXIDUM—U.S.P.

(Zinc Oxid; ZnO.)

Zinc oxid is a fine, white, amorphous powder, without odor or taste. Insoluble in water or alcohol. It is rarely used internally, an average dose being 4 gr. (0.25 Gm.). There is one official preparation:

Unguentum Zinci Oxidi, U.S.P. (20 per cent.).

Physiologic Action.—Zinc oxid is a mild astringent and antiseptic.

Therapeutics.—This drug has been used extensively as a vehicle for making pastes of liquids for treating *gangrenous pulps* and *dento-alveolar abscess*, also for *root-canal fillings*. In the light of our present knowledge of "focal infection" and its relation to systemic disease, all "pastes" of whatever nature should be discarded for filling root-canals. Zinc oxid is the base of the powder for all zinc phosphate cements.

The ointment may be employed to soften and protect the mucous membrane of *dry* and *cracked lips* previous to operating or adjusting the rubber dam. The ointment is also extensively used as a slightly

astringent and protective dressing for *cold-sores, burns, acute ulcers,* and *acute inflammatory skin diseases.*

ZINCI IODIDUM (Nonofficial)

(Zinc Iodid; ZnI_2.)

Zinc iodid is a white, granular powder, without odor, and having a sharp, saline, and metallic taste. It is a very deliquescent salt and liable to absorb oxygen from the air, becoming brown from liberated iodin. Readily soluble in water, alcohol, or ether. It should be kept in glass-stoppered bottles. When used internally the average dose is ½ gr. (0.03 Gm.).

Physiologic Action.—Zinc iodid is astringent, antiseptic, and alterative.

Therapeutics.—This salt may be used as a mild astringent, antiseptic and alterative in cases of *ulcerative stomatitis* and *periodontoclasia.* Talbot suggests using the following remedy in cases of *flabby* and *inflamed gums;* Zinc iodid 15 parts, water 10 parts, iodin 25 parts, and glycerin 40 parts. The salt can also be added to mouth-washes to give astringency to the solution.

ZINCI CHLORIDUM—U.S.P.

(Zinc Chlorid; $ZnCl_2$.)

Zinc chlorid occurs as a white, granular powder, or fused mass, very deliquescent, odorless, and of a caustic, metallic taste. *It is so intensely caustic as to make tasting dangerous,* unless the salt is dissolved in a large quantity of water, in which it is freely soluble; it is also freely soluble in alcohol. It is not used internally. The official preparation is:

Liquor Zinci Chloridi, U.S.P. (50 per cent.).

Physiologic Action.—Zinc chlorid is feebly astringent and antiseptic. It is the most caustic of all the zinc salts, and possesses marked styptic properties. Its prolonged use in the mouth interferes with the secretory action of the salivary glands (Cook).

Therapeutics.—Solutions of zinc chlorid of various strengths have enjoyed an unmerited reputation as disinfectants in dental practice. For years the saturated solution has been mixed with zinc oxid to make the so-called zinc oxychlorid cement, and used for filling root-canals. This cement is not used to-day to any great extent for filling root-canals; but its use is strongly recommended for the purpose of covering the gutta-percha canal filling. Webster proved the material

to be impervious to bacteria, which is a distinct advantage. Black, Poundstone, and others claim this is not true of the ordinary zinc phosphate cements. A 10 per cent. solution may be employed for *arresting profuse hemorrhage* in pressure anesthesia. Applied to *sensitive dentin* it acts as an obtundent. Care must be taken not to use it in deep-seated cavities nearly involving the pulp, as the hydrochloric acid liberated will irritate the pulpal organ. This irritant property may be controlled by dissolving the salt in alcohol and then adding chloroform. A formula for sensitive dentin follows: Zinc chlorid 20 gr. (1.3 Gm.), alcohol and chloroform, of each, ½ fl. oz. (15.0 cc.). The drug has been recommended to be added to mouth-washes to impart astringency to the solution. Its value here has been overestimated, for it is the least astringent of all zinc salts, and its continued use in the mouth changes temporarily the character of the saliva.

CALCII CHLORIDUM—U.S.P.

(Calcium Chlorid; $CaCl_2$.)

Calcium chlorid occurs in white, rather translucent, hard fragments, is very deliquescent, odorless, and of an acrid saline taste. It is freely soluble in water, somewhat less so in alcohol. The average dose is 8 gr. (0.5 gm.).

Physiologic Action and Therapeutics.—Internally administered calcium chlorid increases the coagulability of the blood. This property was first mentioned by Wright, of England, in 1893. It has been used with success in *hemophilia*, and in *small persistent hemorrhages*, like those which sometimes follow the extraction of teeth.

Wright found that the prolonged administration of the drug rather decreases than increases the coagulability of the blood, and that it acts best as a hemostatic by giving it in doses of from 3–10 gr. (0.2–0.6 Gm.) three times a day, for a period of two or three days, and discontinuing its use for a like period. The drug is very irritating to the stomach and should be given after meals, well diluted.

BISMUTHI SUBNITRAS—U.S.P.

(Bismuth Subnitrate; $BiONO_3 + H_2O(?)$.)

Bismuth subnitrate is a heavy white powder, of a somewhat varying chemic composition, odorless, almost tasteless, and slightly hygroscopic. It is insoluble in water and alcohol, but soluble in glycerin in about 12 parts (Hereth). The average dose is 8 gr. (0.5 Gm.).

Physiologic Action.—Upon the unbroken skin bismuth subnitrate simply acts as a protective agent; but upon raw surfaces and mucous membranes it also acts as an astringent and antiseptic. From denuded surfaces absorption of the drug takes place rather speedily, and poisoning has been known to occur from its too frequent application. The symptoms of *bismuth poisoning* are stomatitis, salivation, black discoloration of the mucous membrane of the mouth, and finally ulceration of the throat, diarrhea and albumin in the urine. Because of the protection the insoluble compound affords to the part, and also because it is just sufficiently astringent to act as a stimulant to the sluggish cells, this drug may be called an ideal antiseptic when applied to abraded surfaces.

Therapeutics.—Until recently bismuth subnitrate had not been employed in dentistry. In medicine it has long been a standard remedy in both *acute* and *chronic gastric catarrh* and *gastric ulcer*. Beck some years ago proved its value in *chronic tubercular sinuses*. The drug is now quite extensively employed in *dento-alveolar sinuses*, *pyorrheal-pockets*, and as a packing for *wounds* after surgical operations about the roots of teeth and the alveolar process. The formula for Beck's paste is: Bismuth subnitrate 30 parts, white wax and paraffin, of each 5 parts, and vaselin 60 parts. Mix with heat.

ARGENTUM (Nonofficial)

(Silver; Ag.)

Metallic silver is used extensively in dental practice in the form of a wire for suturing fractured jaws, ligating loose teeth, etc. The most important salt of silver used in dentistry is silver nitrate, which is official.

ARGENTI NITRAS—U.S.P.

(Silver Nitrate; $AgNO_3$.)

Silver nitrate occurs in colorless, transparent, tabular crystals, odorless, and of a caustic and rather metallic taste. It is soluble in about 0.4 part of water and in 30 parts of alcohol at 25°C. The salt darkens on exposure to light, and should be kept in amber-colored bottles. The average dose is $\frac{1}{6}$ gr. (0.01 Gm.). The only official preparation is:

> Argenti Nitras Fusus, U.S.P., Lunar Caustic (Silver Nitrate fused and molded into hard white cones or pencils).

Physiologic Action.—While silver nitrate, in dilute solution, acts as an astringent upon mucous membranes and raw surfaces

in that it contracts the tissues to which it is applied by precipitating the albumin of the cells, in concentrated solutions or crystal form it acts as an unirritating caustic, coating and protecting the parts with white silver albuminate. Much investigation has been done by dentists in regard to the depth of penetration of silver nitrate, especially when applied to the tooth-structure. The prevailing opinion is that its penetration is limited on account of the impenetrable nature of the coagulum formed.

In weak solutions (1:2500), silver nitrate is active as a disinfectant. Internally administered in medicinal doses, its only action is that of an astringent and antiseptic.

The long-continued use of silver nitrate, even when locally applied, may result in a condition known as *argyria*. The manifestation of this condition is a characteristic, bluish-gray discoloration of the skin and mucous membranes. As a rule, it does not interfere with the general health, but the discoloration is permanent.

Therapeutics.—Silver nitrate is a valuable therapeutic agent in dentistry, being used largely for its caustic action. It is chiefly employed for its beneficent effect on *unnaturally exposed tooth-structure*, and on *inflamed mucous membranes* and *ulcerative surfaces*. To *exposed sensitive cementum* it may be applied in from 10 to 20 per cent. solution, the part first being dried; or the surface to be cauterized may be left moist and the solid stick used. Black calls attention to the fact that exposure to sunlight aids the action of the salt. In the absence of sunlight, the electric mouth lamp will be found serviceable.

Dr. Percy R. Howe, of Boston, recommends silver nitrate in the treatment of *gangrenous pulp canals*, after a method introduced by him and known as Howe's "Metallic Silver-reduction." This will be fully considered later in Practical Therapeutics.

This drug is one of the best caustics for destroying *exuberant* and *superfluous granulations*, for which purpose a solution may be used up to 50 per cent. in strength. In *chronic stomatitis* a 2 to 5 per cent. solution may be used with advantage; the pencils may be used in lightly touching *mucous patches*. Elliot recommends a 10 per cent. solution as a local application in the cracks which frequently occur about the hands and feet. It is stated on good authority that there are 60,000 blind people in the United States, and that fully one-third of these unfortunates are blind because of a disease which is easily preventable. This is known scientifically as *ophthalmia neonatorum;* but mothers and midwives simply call it "baby sore eyes." It can be prevented by dropping a few minims of a one per cent. solution of

silver nitrate in the baby's eyes when born. Some States have a law making it obligatory for the physician in attendance at birth to use a solution of the silver compounds.

Precautions.—There is little danger of producing argyria from silver nitrate in dental practice, yet dentists should be familiar with this condition. In using the drug, care should be taken to prevent the cauterization of parts not intended, as the patient's lips, gums, tongue, buccal mucous membranes, etc. Sodium chlorid (common salt) is a positive antidote, as it forms with the drug the insoluble and inert silver chlorid. A solution of the antidote should always be in a convenient place when silver nitrate is used about the mouth.

Incompatibles.—With creosote it causes an explosion. It is also incompatible with organic matter and many salts, as chlorids, bromids, iodids, sulphids, cyanids, carbonates, and phosphates.

OTHER SILVER SALTS AND SOLUBLE COMPOUNDS

An effort has been made by manufacturing chemists to produce compounds of silver which possess the stimulant and disinfectant power of silver nitrate and which will not precipitate albumin or chlorids. Some of these preparations have proved exceedingly valuable.

Argyrol (Silver Vitellin).—This is a compound of a derived vegetable proteid and silver oxid, containing from 20 to 25 per cent. of silver. It occurs in black, glistening, hygroscopic scales, freely soluble in water and glycerin, insoluble in alcohol and oils.

Physiologic Action and Therapeutics.—In strong solutions (20–50 per cent.) argyrol is claimed to be nonirritating to mucous membranes. It, without doubt, possesses marked antiseptic properties. It is recommended in nearly all diseased conditions of the mucous membranes; as in *stomatitis*, *acute ulcerous gingivitis*, *aphthous sore mouth*, *maxillary sinusitis*, *pharyngitis*, and *conjunctivitis*. Brophy recommends the drug in the after-treatment of antral operations. It is used in from 10 to 50 per cent. solutions. It will stain the skin and mucous membrane as well as the clothing. Care should be taken, therefore, in using the drug not to stain the latter. Hot water immediately applied will remove the stain from fabrics. Argyrol will be found useful in *acute coryza*. A few minims of a 10 per cent. solution placed in the posterior nares, with a suitable medicine dropper, will generally check the excessive secretions without discomfort. The head should be held back for a few moments as the solution is applied, permitting the drug to come in contact

with the entire mucous membrane of the nasal openings. The action of the drug is that of an antiseptic and mild stimulant to the congested mucous membrane, and the effect here is highly desirable.

Protargol.—This is a proteid compound containing about 8 per cent. of silver. It occurs as a fawn-colored powder, freely soluble in water. It is claimed to be a good disinfectant, and comparatively free from irritant properties. Its action is similar to that of argyrol, and it is used for practically the same pathologic conditions. The extreme solubility of argyrol and the high percentage of silver which it contains have caused this drug to largely supersede protargol in dental practice.

Silver Preparations, Colloidal.—Under certain conditions involving a very fine state of subdivision, metallic silver and some of its compounds ordinarily insoluble become capable of colloidal suspension, forming with water mixtures closely resembling solutions. These preparations are not precipitated by the ordinary precipitants of silver salts. As a result they can be mixed with organic liquids or injected into tissues or even into the blood-stream without precipitation and without causing marked symptoms of irritation. They possess to a greater or less degree the antiseptic properties of solutions of silver compounds. Several similar preparations of this kind are on the market and are variously known as *cargentos*, *collargol*, *electrargol*. The products are claimed to produce increased leucocytosis. Two of these preparations are recognized by the U.S.P. X.

ARGENTO-PROTEINUM FORTE—U.S.P.

(Strong Silver-Protein; Strong Protargin.)

This is a compound of silver and protein, containing not less than 7.5 and not more than 8.5 per cent. of silver (Ag.) It occurs as a brown, odorless powder, usually somewhat hygroscopic, freely soluble in water, but almost insoluble in alcohol, chloroform, and ether.

ARGENTO-PROTEINUM MITE—U.S.P.

(Mild Silver-Protein; Mild Protargin.)

This is a compound of silver rendered colloidal by the presence of or combination with protein. It contains not less than 19 and not more than 25 per cent. of silver (Ag). It occurs as dark brown, or almost black shining scales or granules; odorless and frequently hygroscopic. The drug is freely soluble in water, but almost insoluble in alcohol, chloroform, and ether. When strong or mild protargin are used it is best to make freshly prepared solutions.

Physiologic Action and Therapeutics.—The colloidal silver compounds are used mainly on mucous membranes, for their antiseptic and disinfectant effects. Strong protargin is most effective in this respect, but is slightly irritant and stimulant. Mild protargin acts as a mucilaginous demulcent and protective; also as a delergent by dislodging pus. This class of preparations should find a wide range of usefulness in dental therapeutics.

The concentrations of solutions for use on mucous membranes range from 0.1 to 10 per cent. for strong protargin and from 5 to 50 per cent. for mild protargin. These are applied every two to four hours, if possible. The solution, as stated, should be recently prepared and kept in dark-colored bottles, protected from light. Ointments and suppositories are used with the same concentrations as the aqueous solutions. Care should be taken with solutions to avoid staining linen. Stains may be removed by 1:1000 solution of mercuric chlorid.

BLEACHERS

Bleachers, or **bleaching agents,** have been defined as agents used to restore the color of tooth-structure. The methods employed in bleaching teeth will be described in detail later in this work. It is intended here to discuss only the drugs used for this purpose. However, it is important that the student should know that the methods of bleaching teeth involve more or less of chemistry. The general principle of bleaching teeth is to chemically change the insoluble colored pigment into a soluble compound so that it may be washed out of the tooth-structure, or else chemically attack the pigment in such a way as to break up its molecular arrangement and thus destroy its color. This may be accomplished by one of two general chemic processes—*oxidation* or *reduction*. The agents used for bleaching teeth, therefore, can be divided into two classes: Those which *oxidize* and those which *reduce* the pigment.

OXIDIZING AGENTS

This class of drugs may also be conveniently subdivided into two classes—*direct* and *indirect* oxidizing agents. The former is any agent from which oxygen may be obtained directly, and the latter is any agent from which oxygen may be obtained indirectly.

The direct oxidizing agents used for bleaching teeth are:

Sodium Dioxid. Acetozone.
Hydrogen Dioxid.* Alphozone.
Oxalic Acid.

There is only one indirect oxidizing agent used and that is:

Chlorin.

SODII DIOXIDUM (Nonofficial)

(Sodium Peroxid; Na_2O_2.)

Sodium dioxid occurs as a light yellow, more or less granular powder. It is the sodium salt of hydrogen dioxid containing at least 90 per cent. Na_2O_2, equivalent to 18.4 per cent. available oxygen. It is chemically soluble in water, and insoluble in absolute alcohol and chloroform. It readily absorbs moisture from the air, thus deteriorating, and is best kept in tightly covered tin cans. The drug is never given internally.

Action.—To speak of the physiologic action of sodium dioxid would be incorrect, for it is such a violent caustic when applied to live tissue that its action cannot be confined within physiologic limits. It is, therefore, rarely used in medicine. As a direct oxidizing agent for bleaching teeth, where its action can be confined to the tooth-structure, it has no equal; especially is this true when the sodium dioxid is decomposed by water, which liberating *nascent oxygen* forms *sodium hydroxid* as a by-product. The nascent oxygen attacks the pigment which has stained the tooth, and the sodium hydroxid attacks any fatty substances which may be present, forming therewith a soluble soap. This double action of sodium dioxid, when decomposed by water, gives to the agent its great advantage as a bleaching agent. The drug may be decomposed by acids with the liberation of nascent oxygen, but by this means the valuable by-product (sodium hydroxid) is destroyed. Used in this way, then, sodium dioxid has no advantage over any other agent which liberates an equal volume of oxygen. It is a fact long recognized by those engaged in the bleaching of hair, feathers, wool, broom-corn, ivory, bone, etc., that the bleaching process is favored when carried on in an *alkaline* medium. This is likewise true in bleaching teeth.

Therapeutics.—In dental practice, where the violent caustic properties of sodium dioxid can be confined to the tooth-structure, this agent has a rather wide range of usefulness. Both the powder and *a solution* made by carefully adding the powder to cold water are used.

There are two important reactions which take place when sodium dioxid is added to water, and it is well to explain these here. If the powder is added to water in small quantities, care being taken to keep down the temperature with ice or cold water, a reaction takes place

which results in a solution containing hydrogen dioxid and sodium hydroxid. This solution freshly prepared may be used for bleaching teeth. The hydrogen dioxid will liberate oxygen which does the bleaching and the sodium hydroxid creates an alkaline medium which favors the bleaching process; it also acts to advantage upon any fats which may be present. The great difficulty here is in obtaining the solution fresh, as the sodium hydroxid gradually decomposes the hydrogen dioxid into water and oxygen, the latter gas being lost. If sodium dioxid is added to water without any precaution as to lowering the temperature, a somewhat different reaction takes place. Here the drug is at once decomposed into oxygen and sodium hydroxid. For all dental purposes this is the best way to use the drug, viz.: Place the powder in the cavity or canal of the tooth and decompose it into oxygen and sodium hydroxid by adding distilled water. In this way it may be used for *bleaching teeth, disorganizing remnants of pulp tissue*, and *enlarging tortuous root-canals*. For the latter purposes the use of the drug should alternate with a 30 per cent. solution of sulphuric acid. Though not employed to any extent in medicine, the drug has been used in *acne*, applied in the form of a paste prepared with liquid paraffin, or as a soap to remove comedones. It has been suggested as an air purifier; this suggestion being based on the theory that the moisture of the air would decompose the chemical gradually, thus liberating oxygen and forming the alkali, sodium hydroxid, which absorbs carbon dioxid. The theory is correct, but it is doubtful if the drug could be used to any practical advantage, except, perhaps, on a limited scale.

Incompatibles.—Sodium dioxid will produce a pyrotechnic display with many of the volatile oils, ether and phenol. It is decomposed by water and acids.

HYDROGEN DIOXID

This direct oxidizing agent has been fully discussed under the heading of Disinfectants. The official 3 per cent. solution is sometimes concentrated or used with other drugs for bleaching purposes. As a bleacher this solution has largely been superseded by the commercial preparation called "caustic pyrozone," which is a 25 per cent. ethereal solution of pure hydrogen dioxid. Like all direct oxidizers, its value depends upon the nascent oxygen which it liberates. For *bleaching teeth* better results are produced when the tooth-structure has been previously moistened with a weak alkaline solution, such as lime-water.

ACETOZONE (Nonofficial)

(Benzoylacetyl Dioxid; $C_6H_5COO.O.COCH_3$. = $C_9H_8O_4$.)

Acetozone, or **benzoylacetyl dioxid,** is made by the oxidation of a mixture of benzaldehyd and acetic anhydrid. It occurs as a white, shining crystalline powder. Slightly soluble in water, alcohol, and fairly so in ether and chloroform. In oils it is soluble to the extent of about 3 per cent. All solvents slowly decompose the drug with the exception of neutral petroleum oils. Not used internally in dentistry.

Action and Uses.—Acetozone belongs to a class of compounds known as the *organic dioxids or peroxids* in which an excess of oxygen has been combined in such a way that it is slowly given off in the nascent state. In the presence of water it hydrolyzes, forming benzoperacid and aceto-peracid which exert marked oxidizing and disinfectant action. Acetozone is used in dentistry as a bleaching agent. Hoff recommends placing the powder in *the cavity of the tooth to be bleached,* moisten with water to bring about the hydrolysis, and hermetically seal. It is claimed to be useful as an antiseptic in ophthalmic, aural and nasal practice, and to give good results by acting as an intestinal antiseptic when given internally, especially in *typhoid fever.*

ALPHOZONE (Nonofficial)

(Succinic Dioxid $(COOH.CH_2.CH_2.CO)_2O_2$ = $C_8H_{10}O_8$.)

Alphozone, or **succinic dioxid,** is an organic dioxid, or peroxid, resulting from the condensation of hydrogen dioxid with succinic anhydrid. It occurs as a fluffy, white, crystalline powder. Soluble in 30 parts of water at ordinary temperature; moderately soluble in alcohol, sparingly so in ether, and insoluble in chloroform. It should be kept in a dark place and in tightly stoppered bottles. Not used internally in dentistry.

Action and Uses.—Alphozone is a powerful oxidizer, and thus becomes an antiseptic, disinfectant, and deodorant. It possesses marked bleaching properties. It is claimed to possess an advantage over hydrogen dioxid as a therapeutic agent in that it does not effervesce with pus nor in contact with living tissues. Alphozone may be used for *bleaching teeth* in the same manner as acetozone. Water does not decompose the drug. It may also be employed for *disinfecting the hands* and such instruments as are not attacked by oxidizing agents. The drug can be obtained in the powder form or in tablets containing 1 gr. (0.065 Gm.) each, which is used for

making solutions for external use. One tablet to 2 fl. oz. (60.0 cc.) makes a suitable disinfectant solution for general use. In *enteric fever* it is claimed to be of special value.

ACIDUM OXALICUM (Nonofficial)

(Oxalic Acid; $H_2C_2O_4 + H_2O$.)

Oxalic acid occurs in the form of transparent, prismatic crystals, is odorless, and of a very acid taste. It is readily soluble in water and alcohol. Not used internally in dentistry.

Action and Uses.—Oxalic acid is a direct oxidizer. As a bleaching agent for teeth its power is limited. Kelley and others have recommended it as a *disinfectant for the hands*. Stains on the skin from potassium permanganate may be readily removed by a solution of oxalic acid.

CHLORUM (Nonofficial)

(Chlorin; Cl.)

Chlorin is a heavy, yellowish-green gas, of a very suffocating odor and a caustic taste. It may be prepared by acting upon chlorinated lime with an acid. The gas is soluble in water.

Action and Uses.—Chlorin is a powerful irritant. When inhaled it causes inflammation, and, at times, edema of the lungs. It has such a great affinity for hydrogen that it will abstract this element from a molecule of water, liberating the oxygen in the nascent state. Because of this fact it is an indirect oxidizing agent, and its bleaching ability as well as its disinfectant power depends upon this property. About the only use made of chlorin in dental practice is as a bleaching agent. It bleaches indirectly. For *bleaching teeth*, compounds and preparations of chlorin, from which the gas is liberated, are used.

In recent years Carrel, Dakin, Crile and others recommend chlorin preparations for the treatment of *infected wounds* and other conditions. Two such preparations are official in the U.S.P. X. These are Chloramin and Dichloramin and have been fully discussed under Disinfectants.

CALX CHLORINATA—U.S.P.

(Chlorinated Lime; $CaOCl + CaCl_2$.)

Chlorinated lime is a mixture of calcium hypochlorite and calcium chlorid. It is prepared by acting upon slaked lime with chlorin gas, and should contain not less than 30 per cent. of available

chlorin. It occurs as a grayish-white powder, having a strong odor of chlorin and a disagreeable saline taste. It is partially soluble in water and alcohol.

Action and Uses.—As the mixture constantly liberates chlorin gas, it is a disinfectant and bleacher. It is used in dentistry as a means of obtaining chlorin for *bleaching teeth.*

LIQUOR SODÆ CHLORINATÆ—U.S.P.

(Solution of Chlorinated Soda; Labarraque's Solution.)

This is a solution of several chlorin compounds of sodium containing not less than 2.5 per cent. by weight of available chlorin.

Action and Uses.—Solution of chlorinated soda is a disinfectant, deodorant and bleacher. Like chlorinated lime, it is used in dentistry as a means of obtaining chlorin for *bleaching teeth.* The solution should be freshly prepared.

REDUCING AGENTS

These are agents which have the power of abstracting oxygen from a compound containing it. The process is called *reduction* or *deoxidation.*

There is only one reducing agent used for bleaching teeth. That is sulphurous acid.

ACIDUM SULPHUROSUM (Nonofficial)

(Sulphurous Acid; H_2SO_3.)

Sulphurous acid is generally used in the form of a 6 per cent. aqueous solution of sulphur dioxid. This was the official solution of the U.S.P. VIII.

Action and Uses.—Sulphur dioxid is a gas which chemically dissolves in water and forms sulphurous acid. This acid has a great affinity for oxygen, and absorbs the latter gas from the air or abstracts it from compounds containing it, thus reducing the compound and forming sulphuric acid.

For *bleaching teeth* it is best to use a mixture of such compounds as, when dissolved, will react upon each other and produce sulphur dioxid within the tooth to be bleached. The gas unites with the water present, forming sulphurous acid, which has a tendency to abstract oxygen from the colored pigment which has stained the tooth, and thus the rearrangement of the elements of the colored molecule destroys its color. Kirk suggests using a mixture of 10 parts of sodium sulphite and 7 parts of boric acid. This mixture

may be packed into the cavity of the tooth, moistened with water, and hermetically sealed. The tooth should subsequently be washed with an alkaline solution to neutralize the acid formed.

ESCHAROTICS OR CAUSTICS

Escharotics or caustics are agents which destroy the tissue upon which they act. While the action of this class of drugs varies with the drug employed, it may be stated in general that their action is purely chemic or physico-chemic. Many of them have an immediate chemic action upon the tissues, and are sometimes called *corrosives*. Nearly all escharotics produce an eschar, the character of which depends largely upon the tissue involved. This eschar is ultimately separated from the living tissues by the inflammatory process thus inaugurated. Some of the agents belonging to this class are quite readily absorbed, and may cause systemic poisoning. The compounds of arsenic—especially arsenic trioxid, long used in dentistry for devitalizing the pulps of teeth—are of this character, as they have a specific poisonous action upon the cells. The salts of chromium and osmium may also be mentioned in this connection. The strong mineral acids abstract water from the tissues and precipitate the proteids; the alkaline hydrates, on the other hand, not only abstract water but dissolve the proteids and form with them soluble compounds.

The chief escharotics are:

Mineral Acids:
- Sulphuric Acid.
- Nitric Acid.
- Hydrochloric Acid.

Phenol.*
Acetic Acid.
Trichloracetic Acid.
Monochloracetic Acid.
Lactic Acid.
Arsenic Trioxid.
Chromium Trioxid.
Osmic Acid.
Potassium Hydroxid.
Sodium Hydroxid.
Zinc Chlorid.*
Mercuric Chlorid.*
Silver Nitrate.*
Actual Cautery.

Several of the above escharotics have been considered elsewhere. Those which have not will here be discussed in detail.

ACIDUM SULPHURICUM—U.S.P.

(Sulphuric Acid; Oil of Vitriol; H_2SO_4.)

Sulphuric acid is a colorless, heavy, oily liquid, without odor, and of an extremely sour taste and acid reaction. It is miscible with water and alcohol in all proportions with the evolution of heat. A precaution to be remembered is that, in diluting, the acid should be

added to the water or other diluent, and not the reverse. The acid is not used internally in dentistry. The official preparations are:

> Acidum Sulphuricum Dilutum, U.S.P. (Contains 10 per cent. of absolute Sulphuric Acid.)
> Acidum Sulphuricum Aromaticum, U.S.P. (Contains about 10 per cent. of Sulphuric Acid in Alcohol with the addition of such aromatics as Ginger and Cinnamon.)

Phenolsulphonic acid ($HC_6H_3(HSO_3)_2O$) is prepared from phenol and chemically pure sulphuric acid. It occurs as a faint reddish-colored, heavy, syrupy liquid, of a rather phenol-like odor and a characteristic acid taste and reaction. It unites with some metals to form salts, notably zinc. It is rather difficult to combine phenol and sulphuric acid so that the resultant mixture may be diluted with water without separation of the original constituents. Inasmuch as the concentrated phenolsulphonic acid is rarely used in dentistry, directions here follow for preparing it so that any dilution may be made: Ninety-seven parts by weight of pure concentrated sulphuric acid are gradually added to 93 parts by weight of pure phenol and the mixture kept at a temperature of about 100°C. for about twenty hours, until only a small percentage of sulphuric acid remains uncombined. When the reaction is thus complete, sufficient distilled water is added to make the finished product assay about 80 per cent. phenolsulphonic acid. This liquid is miscible with water in all proportions; and whenever phenolsulphonic acid is mentioned in these pages this product is meant. It should not be confused with the preparation suggested by Cook, of Chicago, which is a heavy, oily, dark brown liquid made by mixing crude sulphuric acid and crude phenol, and which can only be used in full strength, as water causes a separation of the constituents.

Physiologic Action.—When applied to the skin, accidentally or otherwise, sulphuric acid in concentrated form causes an intense, burning pain, and results in a rapid destruction of tissue. The eschar is at first white, gradually becoming brown. The corrosive effect upon mucous membranes is still more marked than upon the skin. The acid rapidly extracts water from the tissue, the alkalies are neutralized, and the proteids precipitated; this results in the complete destruction of the tissue (dissolution). When taken internally large doses cause burning in the throat and esophagus, violent pain in the abdomen, constant vomiting of dark matter, mixed with blood and mucus, difficult breathing, and ultimate collapse.

Therapeutics.—Sulphuric acid is used in dentistry more than any of the other mineral acids. Because of its violent action upon soft

tissue, it is seldom used as an escharotic except at times on pulp tissue where its action can be controlled. By many it is used in 30 per cent. solution to neutralize the contents of *gangrenous root-canals*, and for enlarging *fine and tortuous canals*. This is known as the Callahan method. It may also be employed to destroy a *remnant of a pulp* in the apical end of a root, and for *dislodging pulp nodules* in the pulp-chambers and root-canals of teeth. A 10 per cent. solution may be cautiously used for sterilizing the dentin and opening the tubules previous to removing a pulp by pressure anesthesia or bleaching the tooth-structure. Care must always be exercised in the use of sulphuric acid, even in weak solutions, not to get the agent on the enamel of the crown of the tooth or soft tissues of the mouth. It should be remembered here that a weak solution of an alkaline salt, such as sodium bicarbonate, will at once neutralize the action of all mineral acids, and such a solution should be ready to use when these agents are employed. Perhaps the most useful combination of sulphuric acid in dental practice is *phenolsulphonic acid*. This agent may be used in nearly every instance where sulphuric acid is indicated and often to advantage. The author especially recommends its use following the initial dressing of formocresol in cases of *gangrenous pulps* and *dental granulomas*. In *caries* or *necrosis of bone*, in *chronic alveolar abscess*, and *periodontoclasia* where the "acid treatment" is indicated, phenolsulphonic acid, properly employed, will give beneficial results.

Incompatibles.—Sulphuric acid is incompatible with alkalies, alkaline carbonates, iodids, and certain salts of lead. It is explosive with oil of turpentine and sugar, and carbonizes syrups because of the sugar therein contained.

ACIDUM NITRICUM—U.S.P.

(Nitric Acid; Aqua Fortis; HNO_3.)

Nitric acid is a strongly corrosive, fuming, caustic liquid, composed of 68 per cent. absolute nitric acid and 32 per cent. of water with which liquid it is miscible in all proportions. It reacts explosively with alcohol and glycerin, and is not used internally in dentistry. The official preparation is:

Acidum Nitrohydrochloricum, U.S.P. (Aqua Regia; Nitric Acid 18 vols.; Hydrochloric Acid 82 vols.).
Acidum Nitrohydrochloricum Dilutum, U.S.P. IX. (Nitric Acid, 10.0 cc. Hydrochloric Acid, 45.5 cc. Distilled Water, 194.5 cc.).

Physiologic Action and Therapeutics.—Nitric acid, though a powerful escharotic, is not as penetrating or painful as sulphuric acid. It produces a characteristic yellow stain on the skin and mucous membrane. In large doses it causes practically the same train of symptoms as sulphuric acid, except that the discoloration is yellow instead of white and then brown. The acid is not used to any extent in dental practice. It may be applied to *warts* and other *fungous growths*, and has proved to be a reliable agent in *phagedenic ulcers*, *chancroids* and *chancres*.

Incompatibles.—This acid is incompatible with alkalies, alkaline carbonates, oxids, lead acetate, and iron sulphate. It explodes with such agents as alcohol, glycerin, phenol, and volatile oils.

ACIDUM HYDROCHLORICUM—U.S.P.

(Hydrochloric Acid; Muriatic Acid; HCl.)

Hydrochloric acid is a fuming, corrosive liquid, consisting of about 32 per cent. of absolute hydrochloric acid. It is miscible with water and alcohol in all proportions. It is not used internally in dentistry. The official preparation is:

> Acidum Hydrochloricum Dilutum, U.S.P. (10 per cent. by weight.)

Physiologic Action and Therapeutics.—The action of hydrochloric acid closely resembles that of the other mineral acids. As a therapeutic agent the strong acid is not used to any extent in dentistry. It is chiefly used to prepare the diluted and other acids. Dilute hydrochloric acid has been used by Andrew and Morris for the *removal of sequestra*, and necrosed bone in *osteitis* and *caries*. It is inferior to phenolsulphonic acid for these purposes.

Some dentists use different strength solutions of hydrochloric acid for cleansing the canals in cases of *gangrenous pulps* and prefer this acid to others used for the purpose, on the basis that the salts formed by the action of hydrochloric acid on tooth-structure are soluble and therefore more easily removed. This slight advantage is outweighed by other qualities and the author prefers the thick, syrupy phenolsulphonic acid.

Incompatibles.—The acid is incompatible with alkalies, carbonates, and silver nitrate.

Treatment of Poisoning by Mineral Acids.—The treatment of poisoning by the mineral acids to be effective should be prompt. The cautious administration of alkalies is indicated to chemically neutralize the acid. Lime-water, magnesia, and soap are best.

Carbonates must be used with care, if at all, on account of the liability to rupture the stomach from the evolution of carbon dioxid (a gas). Stevens cautions against the use of the stomach-pump on account of the risk of piercing the softened esophagus. After the acid is neutralized with the alkaline solutions, demulcent drinks, such as albumin-water, milk and raw eggs, should be given to soothe the parts. To control the pain, opium, or its alkaloids, are indicated, and whisky or brandy should be injected subcutaneously in case of collapse.

ACIDUM ACETICUM—U.S.P.

(Acetic Acid; $HC_2H_3O_2$.)

Acetic acid is a liquid composed of 36 per cent. by weight of absolute acetic acid and 64 per cent. of water. It occurs as a clear, colorless liquid, having a strong, vinegar-like odor, and a purely acid taste. Miscible with water and alcohol in all proportions. The average dose of the *diluted acid* is 30 min. (2.0 cc.). The official preparations are:

> Acidum Aceticum Dilutum, U.S.P. (6 per cent. by weight of absolute Acetic Acid).
> Acidum Aceticum Glaciale, U.S.P. (Glacial Acetic Acid; 99 per cent. absolute Acid).

Physiologic Action.—The concentrated acetic acid when applied locally produces redness, vesication, and ultimately slight sloughing. Internally it causes severe gastritis.

Therapeutics.—Acetic acid is applied externally to *indolent ulcers* of the mouth and *canker sores*. A weak solution may be used as a gargle in cases of *pharyngitis* or *sore throat*. Glacial acetic acid may be applied to *fungous growths* in the mouth. It is also used to remove *warts* and *corns*. The dilute acid or vinegar is especially indicated as an antidote in cases of poisoning by alkalies. The quantity to be given must be governed largely by the probable amount of alkali to be neutralized. In bleaching teeth with sodium dioxid, or in using the caustic alkalies about the teeth, a weak solution of acetic acid should be at hand to neutralize any alkali which may get on the soft tissues of the mouth.

ACIDUM TRICHLORACETICUM—U.S.P.

(Trichloracetic Acid; $HC_2Cl_3O_2$.)

Trichloracetic acid occurs as white, deliquescent crystals, freely soluble in water, alcohol, and ether. It is made by acting on glacial acetic acid with chlorin or on hydrated chloral with fuming nitric acid.

Physiologic Action and Therapeutics.—Trichloracetic acid acts as an escharotic, astringent, and hemostatic. A solution of 5 to 10 per cent. may be applied to *indolent ulcers*, *mucous patches*, etc. A 10 to 20 per cent. solution is an excellent stimulating agent to be forced through a *sinus* in *chronic alveolar abscess* and into a *stubborn pyorrheal pocket.* It may also be employed in this strength solution as a hemostatic in case of *profuse hemorrhage* after the removal of a pulp by pressure anesthesia. The pure drug or a concentrated solution has been employed to some extent for the removal of small growths about the mouth, such as *hypertrophied gum* or *pulp tissue.* The agent is also used for the removal of *warts* and *corns.*

Monochloracetic Acid.—($HC_2H_2ClO_2$).—This agent occurs as a white crystalline substance, soluble in water and alcohol. As shown by the formula, only one of the hydrogen atoms in glacial acetic acid is displaced by chlorin. Harlan recommended the use of this agent in the treatment of *gangrenous canals* of teeth. The remedy never gained any favor, as its action is uncertain.

ACIDUM LACTICUM—U.S.P.

(Lactic Acid; $HC_3H_5O_3$.)

Lactic acid is an organic acid usually obtained by the fermentation of grape-sugar or milk-sugar. The official preparation is composed of not less than 85 per cent. nor more than 90 per cent. absolute lactic acid. It occurs as a colorless, or slightly yellow, syrupy liquid, nearly odorless, having an acid taste, and absorbing moisture on exposure to air. Besides being miscible with water, it will mix with alcohol and ether in all proportions. The average dose is 30 min. (2.0 cc.).

Physiologic Action and Therapeutics.—Lactic acid acts as a mild caustic on mucous surfaces. It is also a stimulant and refrigerant. Younger advocated the use of the official acid as a stimulating agent in *periodontoclasia* (*pyorrhea alveolaris*). After the roots are scaled, the acid is warmed and injected into the pockets. Stevens recommends a 20 to 50 per cent. solution to be applied to *tuberculous* and *lupous ulcerations of mucous membranes.*

ARSENI TRIOXIDUM—U.S.P.

(Arsenic Trioxid; Arsenous Acid; White Arsenic; As_2O_3.)

Arsenic trioxid occurs either as an opaque, white powder, or in irregular, heavy masses of two varieties: one, amorphous, transparent, and colorless, like glass; the other, crystalline, opaque, and

white, resembling porcelain. Contact with moist air gradually changes the glassy into the white, opaque variety; and frequently the same piece has an opaque, white outer crust enclosing the glassy variety. Both are odorless and tasteless. The drug is soluble in water, the amorphous or glassy variety being somewhat more soluble than the crystalline variety. It is sparingly soluble in alcohol and ether, but freely soluble in glycerin, hydrochloric acid and alkaline solutions. In the presence of water it reacts and forms arsenous acid (H_3AsO_3). The average dose is $\frac{1}{30}$ gr. (0.002 Gm.).

Physiologic Action.—Internally administered in the proper form and dose arsenic acts as an alterative and tonic, improving the appetite and increasing the secretions. It modifies the blood, and in this manner removes morbid conditions. For this reason it is frequently used in the treatment of *syphilis*, *phthisis*, and certain *nervous diseases*. *Salvarsan* and *neosalvarsan*, newer remedies for syphilis, and which will be discussed later, are compounds of arsenic. The drug has been used by some people as a beautifier of the complexion to whiten the skin. Care must be exercised in giving arsenic internally owing to its cumulative effect which may develop poisonous symptoms.

It is the *local action* in which dentists are most interested. Applied to denuded surfaces, such as an exposed pulp, unless its action is controlled, arsenic trioxid is a powerful and painful escharotic. It is readily absorbed by the tissue, and exerts a specific poisonous action upon the cells. It is a peculiar escharotic, and stands in a class by itself. Long[1] states that "the dry powder may be placed on the tongue and allowed to remain for one minute without causing the slightest irritation and, if then thoroughly removed, without producing any effect upon the tissues. On the contrary, if it is allowed to remain until it becomes dissolved and penetrates the tissues, extensive sloughing will result. It acts only after being absorbed by the tissue elements, altering or destroying their vital processes in an obscure manner. Because of this action it is difficult, if not impossible, to limit or antagonize its influence upon the tissue which it has penetrated; and its penetration is not limited by any action of its own, as it does not coagulate albumin. The fact of its being tasteless and nonirritating at first renders its use about the mouth the more dangerous, for by careless handling it may become lodged about the teeth or beneath the edge of the gum, and its presence be not appreciated for hours, until devitalization of the tissue has begun."

[1] Dental Materia Medica, Therapeutics and Prescription Writing.

Under certain conditions, which are not well understood, the pulp tissue, though exposed, will absolutely resist the action of arsenic trioxid. When this occurs the tissue will generally be found to be equally resistant to other drugs. It is claimed that many of the peasants of Austria have acquired a toleration for the drug, and can take large doses without any untoward effects.

Poisoning and Treatment.—Arsenical poisoning may well be considered in two forms—*local* and *systemic*. *Local arsenical poisoning* occurs most frequently by the escape of arsenical preparations from the cavity during the devitalization of pulp tissue. There is seldom any pain connected with the devitalization of the gum tissue, and herein lies the great danger of extensive necrosis of the soft and frequently the bony structures. The prominent symptom is a white gum, absolutely lifeless; there may be pain, most frequently this symptom is absent; the tooth becomes sore to percussion. In the more severe cases the destruction of soft tissue, if unnoticed, goes on until the alveolar process between the affected teeth becomes involved and is destroyed. Sometimes the affected tooth is lost, together with one or two teeth on either side.

In the *treatment of local arsenical poisoning* where the drug has remained only long enough to cause devitalization of the gum tissue, all that is necessary is to first wash the part with an antiseptic solution and then mechanically pick off the dead or sloughed tissue with sterile pliers until hemorrhage ensues, if this is possible; after which stimulating disinfectants should be employed. Here is a good place to use the official solution of hydrogen dioxid. The cavity is open and there is no danger of spreading a possible infection. After removing the dead tissue and disinfecting, the author suggests drying the part and covering it with the oleaginous euroform paste or with analgentum. The patient should be instructed to keep the mouth clean by the use of an antiseptic wash, and the local treatment repeated every day until granulations begin to form; usually one or two treatments will suffice.

In those severe cases where the agent has penetrated to and devitalized the alveolar process, as well as the overlying soft tissue, the first treatment is surgical. After washing with an antiseptic solution, the affected part should be thoroughly curetted with a bone curet or a suitable bur in the engine. It may be necessary in extensive cases to extract the affected tooth, after which the treatment is practically the same as has been outlined above, except where there has been much removal of tissue in operating it is best to pack the part at first with plain gauze thoroughly saturated with the euro-

form paste or with analgentum. The latter is preferable here for it is sufficiently stiff to stay in place without the gauze, which in the mouth at best is likely to invite infection. The case should be watched closely, and the stimulating treatment kept up until the part has healed. The tissue in the interproximal space will never be fully reproduced, and will always be the source of more or less annoyance.

Acute systemic arsenical poisoning is manifested by severe abdominal pains, vomiting and purging of "rice-water," persistent thirst, muscular cramps, cyanosis, and collapse. Death usually occurs in from one to three days, and is often preceded by delirium, convulsions, and coma. If recovery follows, the acute symptoms may be gradually replaced by those of *chronic arsenical poisoning*. This condition may also follow the prolonged use of the drug as a medicine, may result from the use of foods or liquors contaminated with arsenic (beer, etc.), may occur from constant inhalation of dust arising from wall-paper or other fabrics colored with arsenical pigments, or may be acquired by workmen in arsenic mines, or in factories in which fumes of the metal are formed. This form of poisoning may be manifested by gastroenteritis, conjunctivitis, and catarrh of the upper air-passages, anemia, peripheral neuritis, and various cutaneous lesions.

In the treatment of *acute systemic arsenical poisoning*, emetics should be promptly given or the stomach emptied by means of the stomach-pump. The best chemic antidote is freshly prepared ferric hydroxid or ferric hydroxid with magnesia, administered while moist in doses of a tablespoonful or more every ten or fifteen minutes. These compounds themselves are harmless and act by forming insoluble arsenites. Dialysed iron liberates in the stomach a certain amount of free ferric hydroxid and may also be given. This agent has also been recommended in local arsenical poisoning, but its use here is of no benefit, and is wrong (see p. 379). Demulcents and opiates are usually indicated.

Therapeutics.—Arsenic trioxid is used only in dental practice for the purpose of *devitalizing the pulp tissue*. The agent was introduced to the dental profession by Spooner, of Montreal, in about 1836. He first advocated its use for the treatment of sensitive dentin, for he discovered that by sealing the drug in a cavity for a few days, the most sensitive dentin yielded to its influence. The fact, however, that nearly all teeth thus treated subsequently gave trouble because of the death of the pulp and the usual sequelæ, led the profession to abandon this agent for the purpose for which it was introduced; but

it has ever since been used as a means of destroying the vitality of the pulp. In fact, until the last few years, it was the only agent employed with any satisfaction. The detail method of using arsenic trioxid as a devitalizing agent will be discussed later. It is well to remember here, however, that when the drug is applied to the pulp of a fully developed tooth, its action and effect are confined to the pulp tissue only, as the organ dies by strangulation at its apex due to the inflammatory reaction from the drug when thus used. Here thrombosis and death of the pulp take place and absorption of the drug by continuity is not likely to occur. This is not true in teeth the roots of which are not fully developed, as in young patients; therefore, arsenic trioxid should be used very cautiously in such cases, if at all. This does not mean that the drug may be used indiscriminately in any case. There is no excuse for careless technic in the local use of the agent.

CHROMII TRIOXIDUM—U.S.P.

(Chromium Trioxid; Chromic Acid; CrO_3.)

Chromium trioxid, called also chromic acid, occurs in small, crimson crystals or rhombic prisms of metallic luster. The drug is without odor, very deliquescent, and thus freely soluble in water. It should be kept in glass-stoppered bottles, and great caution should be observed to avoid an explosion when brought in contact with organic substances, such as cork, tannic acid, sugar, alcohol, glycerin, ether, and collodion. It is very destructive to animal and vegetable tissues.

Physiologic Action and Therapeutics.—Chromic acid is an active escharotic, due to its powerful oxidizing influence. Internally administered, it causes intense pain in the abdomen, vomiting and purging; often there is blood in the vomit and stools, ultimately collapse, which frequently ends in death. Alkalies neutralize the compound, but the salts thus formed are poisonous and the stomach should be emptied after the administration of the antidote. Chromium trioxid has been employed for the purpose of devitalizing the pulp tissue in children's teeth. Though the agent may be considered safer than arsenic trioxid, because it is less penetrating, its action is uncertain and unreliable. Stevens recommends a solution of from 20–30 gr. (1.3–2.0 Gm.) to the ounce (30.0 cc.) as a stimulating application in *mucous patches*. The fused crystals on a suitable probe may be used with excellent results in the removal of *hypertrophied gum or pulp tissue*, and in closing small *salivary fistulæ*.

Incompatibles.—With organic substances, such as cork, tannic acid, alcohol, glycerin, etc., chromic trioxid easily explodes.

Potassium Dichromate ($K_2Cr_2O_7$).—This salt, sometimes called potassium bichromate, may be employed in weak solutions (5 per cent.) in *indolent ulcers, mucous patches* and *sloughing wounds.*

OSMII TETROXIDUM (Nonofficial)

(Osmium Tetroxid; Osmic Acid; OsO_4.)

Osmium tetroxid, called also osmic acid, occurs in yellow, crystalline needles, possessing a pungent odor and burning taste. It is slowly soluble in water (1 : 50); also soluble in alcohol and ether, but the solutions decompose.

Physiologic Action and Therapeutics.—This is a very irritant and caustic agent. When injected into the tissues, even in weak solutions, the blood and tissues turn black, but healing of the wound generally proceeds without interruption. Intraneural injections are used to produce degeneration of nerves for the relief of persistent *neuralgias.* Murphy, Bennett, and others claim excellent results. The affected nerve is exposed by a small incision, and a 1.5 per cent. solution, freshly prepared, is injected into its substance at different points, to the amount of from 5–10 min. (0.3–0.6 cc.). If successful, the effects may persist for several months, when it may become necessary to repeat the injection as the cure is rarely, if ever, permanent. Murphy especially mentions the inherent tendency of nerve tissue to regenerate.

POTASSII ET SODII (Nonofficial)

(Kalium and Natrium; Potassium and Sodium; K and Na.)

Potassium and **sodium** are known in chemistry as *alkali-metals;* they vigorously decompose water at ordinary temperatures, forming the hydroxid (hydrate) of the metal, with liberation of hydrogen. The metals occur in soft cylinders, having a silver-white color; and on account of their tendency to combine with oxygen they must be kept under a hydrocarbon liquid, such as coal-oil, benzene, etc.

Action and Therapeutics.—Because of their violent action on soft tissue they are not used as such in medicine. Schreier, of Vienna, introduced a mixture of these metals as a remedy for treating *gangrenous root-canals.* When the mixture is placed in a canal containing dead pulp tissue a violent reaction takes place, water is decomposed, with the evolution of considerable heat, and the hydroxids of the metals are formed. The potassium and sodium

hydroxids unite with the fatty products present to form soluble soap, which may be removed by washing. Thus it will be seen that the contents of the canal are chemically destroyed and physically removed, leaving the canal white and clean. Rhein recommends a further sterilization of the canal with a 1 : 500 solution of mercury bichlorid in a 3 per cent. solution of hydrogen dioxid. The use of metallic potassium and sodium will be discussed in detail in that part of this book devoted to Practical Therapeutics.

POTASSII HYDROXIDUM—U.S.P.

(Potassium Hydroxid; Caustic Potash; KOH.)

Potassium hydroxid, more commonly called caustic potash, occurs in hard, white, translucent pencils or fused masses, odorless, and having an acrid and caustic taste. It is freely soluble in water and in alcohol. The official preparation is:

Liquor Potassii Hydroxidi, U.S.P. (5 per cent.).

SODII HYDROXIDUM—U.S.P.

(Sodium Hydroxid; Caustic Soda; NaOH.)

Sodium hydroxid, or caustic soda, occurs in hard, white, translucent pencils or fused masses, odorless, and having an acrid and caustic taste. It is freely soluble in water and in alcohol. The official preparation is:

Liquor Sodii Hydroxidi, U.S.P. (5 per cent.).

Physiologic Action and Therapeutics.—The action of caustic potash and caustic soda is similar. They may be classed among the strongest and most penetrating escharotics known. *They should be handled about the mouth and other soft tissues with the greatest caution.* Their action is both rapid and painful. When applied to soft tissue they produce a slough which separates in a few days leaving a granulating ulcer. The escharotic effect is caused by the abstraction of water from the tissues; this softens the latter, and the hydroxyl radical forms with the proteids a soluble alkaline albuminate. When either are taken internally in large doses they produce all the symptoms of corrosive poisoning—burning in the throat and esophagus, intense pain in the abdomen, vomiting and purging of mucus and bloody matter, dysphagia, and ultimate collapse. Small doses freely diluted have the same action as the alkaline carbonates—that of an *antacid.*

Caustic potash and caustic soda are sometimes employed in dental practice to destroy *exuberant granulations.* They are also

used in about 10 per cent. solutions to cauterize and destroy a *remnant of a pulp* and to disorganize and aid in the removal of all organic material from the canals of pulpless teeth. This is recognized to-day as absolutely essential in the treatment of these teeth. Whenever these alkalies are employed in the canals of teeth, care must be taken not to force them through the root-end, and their caustic action should be neutralized with weak acids.

Treatment of Poisoning.—The treatment of poisoning with the caustic alkalies to be effective must be prompt. Dilute acetic acid or vinegar will neutralize the alkali and should be given at once. Demulcent drinks are indicated to soothe the corroded parts, and opium to control the pain.

Hydrofluoric Acid (HF).—This is a colorless gas, freely soluble in water. It may be obtained commercially in solution, and because of its power to etch glass, it must be kept in rubber or gutta-percha bottles. On account of its extremely irritating and penetrating property, it is not employed as a therapeutic agent, but is used extensively in dentistry for etching porcelain inlays. It must be handled with the greatest care, for if it is accidentally applied to the soft tissue and not instantly neutralized it will penetrate deeply and produce an ugly ulcer. Many cases of severe local poisoning by the agent have been reported, and it is largely for this reason that it has been included in this work on therapeutics.

The treatment of local poisoning consists in neutralizing the drug chemically by the use of alkalies. A weak solution (5 per cent.) of ammonia water serves the purpose nicely, and the sooner the application is made after the discovery of the burn, the less destruction of tissue there will be. To apply the antidote, the part can be wrapped in plain sterile gauze and this saturated with the remedy. The ammonia will irritate the part and probably cause pain, but the acid must be neutralized, even at the expense of causing pain. After we are reasonably certain that the acid is neutralized, the burn should be antiseptically treated in the usual way. The euroform paste is an excellent remedy to employ.

Ionization.—This is the process of dissociating the ions or radicals of a salt or compound by setting them free by means of the electric current (electrolysis). When the process is used in the treatment of disease, it is called *ionic medication*. Ionization with solutions of zinc chlorid and iodin is frequently used in the treatment of *dental granulomas* and *infections* about the root-ends of pulpless teeth. Whether the benefit comes from the supposed fact that the tissues thus treated are sterilized by virtue of the ions being set free,

or from the cauterization by the current used, is a debatable question. Price is of the latter opinion. Others believe the results are brought about from stimulation of the periapical tissue rather than from sterilization. In the treatment of infected wounds it is well to remember that stimulation is more essential than absolute sterility. Carrel claims that in such cases, a degree of sterility known as surgical sterility is all that is required. In the heading of wounds or tissue regeneration, it is well to remember that there is a difference between *surgical asepsis* and *bacteriologic sterility*. A condition of surgical asepsis is sufficient for tissue regeneration, while gross infection leads to death and tissue destruction.

Actual Cautery.—The cauterization of tissue by means of heat should be considered briefly under the heading of *Escharotics*. This is accomplished by means of the hot iron or platinum wire, or the galvano-cautery, and affords a prompt and powerful means of destroying tissue. The process is not as painful as one would naturally suppose, and may be used for the purpose of destroying *hypertrophied gum tissue* and other growths. The dental switch boards have an attachment by which this means of cauterization may be easily and practically applied.

IRRITANTS AND COUNTERIRRITANTS

Irritants have been elsewhere defined as agents which, when applied to the skin or mucous membrane of the mouth, produce active hyperemia or inflammation. When irritants are applied to a normal part for the purpose of influencing favorably a diseased part, usually deep-seated, they are called **counterirritants,** and the process *counterirritation*. It is for this latter purpose that irritants are largely employed in dentistry. The extent to which counterirritation may be carried depends upon how severely diseased is that part which the irritation of the normal part is intended to influence. The agents used are subdivided into different classes according to the degree of irritation following their application. Those which simply produce active hyperemia (redness) of the surface are called *rubefacients;* those which act more severely and cause the formation of a blister are known as *vesicants* or *epispastics*. In many instances the same agent may produce a rubefacient or a vesicant effect, depending upon the strength of the drug and the duration of its application.

Counterirritation may be carried to a greater degree of intensity when a true escharotic effect (destruction of tissue) is produced. This, however, is seldom necessary in dental practice. In fact, as

a rule, it should be guarded against, for the formation of an ulcer in the mouth is liable to so cripple the cells that a *mixed infection* may readily follow.

Care should be exercised in the application of counterirritants when the inflammation is superficial. To apply an irritant directly to an inflamed part would only tend to aggravate the condition. Here the site of application should be a short distance from the diseased part. In all deep-seated inflammations, or in cases of neuralgia, it is best to make the application directly over the affected part.

Long[1] states that "the remedial effect of a counterirritant is probably brought about by a threefold action. They influence, *first*, the circulation by causing a hyperemia at the point of irritation, the tendency of the blood supply will be in that direction and away from the original disease; *second*, they turn the attention of the system toward the new point of irritation and away from the disease, partly a mental effect; and, *third*, they influence the innervation of the diseased part by the reflex influence of the irritation. In the sum of their effects they stimulate the movement of fluids within the tissues; hence they are regarded as lymphatic stimulants, and are often employed to stimulate the absorption of a serous or inflammatory exudate."

Counterirritation may be said to be truly indicated in dental practice in the treatment of *pericementitis* and *trigeminal neuralgia*.

The most important irritants used in dentistry for counterirritation are:

Heat.	Cantharides.
Iodin.*	Chloroform.
Capsicum.	Aconite.
Mustard.	Camphor.
Oil of Turpentine.	Volatile Oils.*
Menthol.*	

Heat.—This physical agent occupies a prominent place in dentistry as a counterirritant, because of the convenience of the variety of forms and the different degrees in which it can be utilized. Moderate heat applied over a deep-seated inflammation will at once produce active hyperemia. The heat may be gradually carried to a higher degree with comfort to the patient until the serum escapes from the engorged blood-vessels, thus promoting *resolution*. Hot water, the hot-water bag, hot foot-bath, and dry and moist poultices,

[1] Dental Materia Medica, Therapeutics and Prescription Writing.

are all employed in various manners in the treatment of *pericementitis*, *acute alveolar abscess*, *neuralgias*, and for the absorption of *serous* or *inflammatory exudates*.

CAPSICUM—U.S.P.

(Cayenne Pepper.)

Capsicum is the *dried ripe fruit* of *Capsicum frutescens*, a plant growing in tropical America, in Asia, in Africa, and cultivated in gardens. The active principle is *capsicin*, which appears in the form of colorless crystals and has an exceedingly pungent odor; other constituents are a volatile alkaloid, fixed and volatile oil, and fatty acids. The average dose is 1 gr. (0.06 gm.). All of the official preparations may be used in dentistry. They are:

Tinctura Capsici, U.S.P. *Dose*, 8 min. (0.5 cc.).
Oleoresina Capsici, U.S.P. *Dose*, ½ gr. (0.03 Gm.).
Emplastrum Capsici, U.S.P. (externally).

Physiologic Action.—Applied to the skin or mucous membrane, capsicum produces a burning sensation and results in a rubefacient or vesicant effect, depending upon the concentration of the drug. Taken internally, in medicinal doses, it creates a sense of warmth in the stomach, stimulates the circulation, and aids the digestive process. In large doses it acts as an irritant poison.

Therapeutics.—Capsicum is used chiefly as a rubefacient, stomachic, and carminative. In dentistry advantage is taken of its irritant properties, and it is largely employed as a counterirritant in *pericementitis*. The oleoresin is the most irritating preparation. The official plaster may be prepared by spreading the oleoresin upon resin plaster; this may be cut in convenient form and applied to the dried gum over the affected tooth, resulting in a small blister, but having a beneficial effect upon the deep-seated inflammation. When a rubefacient effect only is desired, the powdered drug may be confined in small concave rubber disks and pressed on the gum, suction holding the remedy in place. Such rubber disks are on the market.

SINAPIS ALBA (Nonofficial)

(White Mustard.)

SINAPIS NIGRA—U.S.P.

(Black Mustard.)

White mustard is the *seed* of *Sinapis alba*. **Black mustard** is the *seed* of *Brassica nigra*. Both of these herbs are cultivated exten-

sively in Europe and America. The powdered mustard of commerce is a ground mixture of white and black seed, often more or less adulterated. Mustard in the dry state is not irritating, but in the presence of water it is extremely irritating, and for this reason: White mustard contains a ferment, *myrosin*, and a glucosid, *sinalbin*. In the presence of water the myrosin acts upon the sinalbin and separates from it an irritant volatile oil.

Black mustard contains the same ferment, *myrosin*, and a glucosid, *sinigrin*, which by the action upon it of the ferment in the presence of water also converts it into an intensely irritant volatile oil. This oil of mustard is official, and to it is due both the pungent taste and odor of the moistened powder. Average emetic dose, 2½ dr. (10.0 Gm.). The following preparations are official:

Emplastrum Sinapis, U.S.P. (externally).
Oleum Sinapis Volatile, U.S.P. (Volatile Oil of Mustard).
Dose, ⅛ min. (0.008 cc.).

Physiologic Action.—Mustard made into a paste with water and applied to the skin, or the powder applied to the moist mucous membrane, causes redness, heat, and a burning pain. Any degree of irritation, from a slight rubefacient effect to severe vesication, may be produced. It should be remembered that the presence of moisture is necessary for the irritant action of mustard, the dry powder is not irritating. Hot water should not be used, as the high heat tends to destroy the ferment necessary to evolve the irritating oil from the glucosid.

Taken internally in small doses, mustard acts as a carminative. In large doses it acts as an emetic, producing prompt emesis without depression, owing to the reflex stimulation of the cardiac and respiratory centers.

Therapeutics.—Mustard is useful in dentistry as a rubefacient. The paper, which was formerly official, cut in proper form, may be applied to the *moist* gum in *nonseptic pericementitis*. Concave rubber cups may also be used to hold the powder, and applied by suction. Powdered mustard may be mixed with warm water to bring about the reaction necessary to produce the irritant volatile oil, and this added to the hot water in taking a hot foot-bath for counter-irritant purposes. To add the mustard direct to the hot water would defeat the object for which the drug is used, as the heat checks the action of the ferment.

On account of the prompt emetic properties of mustard the drug may be employed in cases of *narcotic poisoning*, the dose being a

tablespoonful stirred up in warm water, and repeated in fifteen minutes, if necessary.

The drug is sometimes used in *neuralgia* and *muscular rheumatism*. The blisters produced by mustard heal with difficulty; therefore, extensive vesication should be guarded against.

TEREBINTHINA (Nonofficial)

(Turpentine.)

Turpentine is a *solid oleoresin*, or pitch, obtained from *Pinus palustris* and other species of *Pinus*, growing in the Southern United States, especially in North Carolina. The oleoresin exudes from the pine tree when the bark is cut, and when subjected to distillation it yields a volatile oil, which is official, and a solid residue called resin or rosin, also official.

OLEUM TEREBINTHINÆ—U.S.P.

(Oil of Turpentine.)

Oil of turpentine is a thin, colorless liquid, highly inflammable, and of a characteristic odor and taste. It should be kept in well-stoppered bottles, protected from light. The rectified oil is made by distilling the ordinary oil with lime-water. This is the preparation which is largely used in dentistry and the one always used for internal medication. Average dose is 10 min. (0.6 cc.) in emulsion. The official preparations are:

Oleum Terebinthinæ Rectificatum, U.S.P.
Emulsum Olei Terebinthinæ, U.S.P. (15 per cent.).
Liniment Terebinthinæ, U.S.P. IX (35 per cent. with Resin Cerate)

Physiologic Action.—When applied to the skin, the drug dilates the cutaneous blood-vessels, producing a sensation of heat and redness, and, if continued long, vesication follows. The drug has decided antiseptic properties, and even in dilute solutions prevents fermentation and putrefaction. Taken internally in medicinal doses, it produces warmth in the stomach, quickened respiration, and increases the rate and tension of the pulse. It also acts as a circulatory stimulant and diuretic.

In large doses it produces all the symptoms of an irritant poison. Some individuals are peculiarly susceptible to the drug, and an erythematous or papular eruption may result from either its internal or external use.

Therapeutics.—Externally, oil of turpentine may be used as a rubefacient in various inflammatory affections. In an *acute alveolar abscess* a turpentine stupe may be employed to advantage. The latter is made by soaking a large piece of flannel in boiling water, wringing it dry, and folding it several times until it is about 6 in. square; from 10 to 30 min. (0.6–2.0 cc.) of the oil are then distributed over it, and it is quickly applied to the cheek of the affected side and covered with several layers of fabric. The formerly official liniment makes an excellent remedy to be applied in cases of *neuralgia* and *muscular rheumatism*.

RESINA—U.S.P.

(Rosin; Colophony.)

Rosin is the residue left after distilling the volatile oil from the concrete oleoresin obtained from *Pinus palustris*, and from other species of *Pinus*. It generally occurs in sharp, angular, transparent, amber-colored fragments, frequently covered with a yellow dust; brittle at the ordinary temperature; odor and taste slightly terebinthinate. It is freely soluble in alcohol, ether, chloroform, benzene, fixed or volatile oils. Formerly there was one official preparation:

Emplastrum Resinæ; U.S.P. IX (Rosin Plaster).

Therapeutics.—Rosin is recommended by Callahan to be dissolved in chloroform, making a thin solution to be used in *filling the canals of pulpless teeth* with gutta-percha. Callahan's "rosin solution" contains rosin 12 gr. (0.8 Gm.) and chloroform 3 fl. dr. (12.0 cc.). Rosin is also used as the binding substance in the author's **Dentinoid** used in the *protection of the dental pulp* and in *filling the canals of pulpless teeth*. The detailed use of this product will be fully explained under Dental Therapeutics. A thick, syrupy solution of rosin in alcohol or chloroform should be kept in every dental office as a *cavity varnish*, or for the *protection of the tooth structure* when using agents which stain the tooth, such as the Howe method.

TEREBENUM—U.S.P.

(Terebene.)

This is a liquid hydrocarbon made by oxidizing oil of turpentine with strong sulphuric acid. The average dose is 4 min. (0.25 cc.).

Terebene has proved to be a very satisfactory remedy in *bronchitis* with free expectoration. It has also been used in *phthisis*, and may be inhaled from a spray or from the sponge of a respirator. Harlan

recommended its use for *gangrenous root-canals;* but, like the essential oils, its use here is unreliable.

CANTHARIS—U.S.P.

(Cantharides; Spanish Flies.)

Cantharides, commonly called Spanish fly, is the *dried* and *powdered beetle* or *insect, Cantharis vesicatoria*, indigenous to Southern and Central Europe. The active principle is *cantharidin*, which is also found in a number of beetles. The drug is used only externally in dentistry. The official preparations are:

Tinctura Cantharidis, U.S.P.
Ceratum Cantharidis, U.S.P.
Collodium Cantharidatum, U.S.P. IX (60 per cent.).

Physiologic Action.—Cantharides is a powerful irritant, though rather slow in its action. When applied to the skin or mucous membrane, the drug excites a tingling and burning sensation, producing redness and, later, vesication. In many instances no pain is caused in raising the blister. Its long-continued application often results in pustulation, ulceration, and sloughing.

The drug not only causes vascular dilatation of the part to which it is applied, but reflexly dilates the blood-vessels of the deep-seated organs underneath, thus acting as a counter irritant. This observation has been physiologically proved and is well known.

The active principle, cantharidin, may be absorbed through the unbroken skin, and is quite readily absorbed through the mucous membrane, thus its constitutional effects may result from the external use of the drug. The toxic symptoms are great pain in the throat, stomach, and bowels, excessive thirst, irritation of the genitourinary tract with a desire to urinate constantly, albuminous and bloody urine, painful erections of the penis in males, and in women abortion may follow the irritant effect of the drug upon the pelvic viscera. While these symptoms are not liable to follow the use of the drug in dental practice where a limited area is selected as the site of application for counterirritant purposes, it is, nevertheless, well to be familiar with them.

Treatment of Poisoning.—The stomach should be emptied, and demulcents given freely to relieve the irritation. Opium may be required to relieve the pain, and stimulants administered, if necessary. Oils and fatty substances dissolve the cantharidin, and thus hasten its absorption; they should therefore be avoided as demulcents.

Therapeutics.—Cantharides may be used as a counterirritant in cases of *severe pericementitis*, and as it dilates the arterioles subjacently the effect of the drug will ultimately afford relief. Its action is slow but certain. The cerate may be applied as a plaster or the collodion as a varnish. To insure greater activity of the drug, the site of application should be oiled. In *facial neuralgia* cantharides is valuable, the preparation being applied behind the ear. The drug is the chief ingredient of many hair tonics.

ACONITUM—U.S.P.

(Aconite; Wolfsbane; Monkshood.)

Aconite is official in the form of the *dried tuberous root* of *Aconitum Napellus*, a plant growing in Europe, Asia, and in America, mostly in mountainous regions. The root closely resembles horseradish; the latter, however, has a pungent odor when scraped, while aconite is odorless. The root at first has a sweetish taste, but soon produces a sense of warmth and tingling, followed by numbness. The active principle is *aconitin*, also official under the title **Aconitina,** U.S.P. This is an alkaloid, occurring in both the crystalline and amorphous form—colorless or white rhombic prisms or prismatic powder, is without odor, permanent in the air, and when brought in contact with the mucous membrane, even in dilute solutions, produces a characteristic tingling and more or less anesthesia. The average dose of aconitin is $\frac{1}{400}$ gr. (0.00015 Gm.). The official preparation of aconite is:

Tinctura Aconiti, U.S.P. (10 per cent.). *Dose*, 5 min. (0.3 cc.).
Fluidextractum Aconiti, U.S.P. IX. *Dose*, ½ min. (0.03 cc.).
Extractum Aconiti, U.S.P. IX. *Dose*, $\frac{1}{6}$ gr. (0.01 Gm.).
Linimentum Aconiti (nonofficial; externally).

Physiologic Action.—Aconite is a true circulatory depressant. It may also be considered a nervous sedative. Applied to the mucous membrane or to the skin for any length of time, it first irritates, causing stimulation, and then depresses the sensory nerve-endings, producing, respectively, tingling, numbness, and local analgesia. The drug lowers the blood-pressure by directly depressing the heart. In the febrile state, moderate doses of aconite cause a decided fall of temperature. Butler claims this is due to various causes: (1) The slowing of the circulation, diminishing the metabolism; (2) the peripheral action of the drug, causing dilatation of the cutaneous blood-vessels; (3) the depressant action upon all muscle-tissue.

Toxicology.—Poisoning by aconite is first manifested by a peculiar tingling sensation of the tongue and lips, which soon extends to the fingers, and may affect the entire surface of the skin. The pulse becomes slow and weak; later it may become rapid and irregular; the respiration is slow and feeble. There is an extreme muscular weakness, especially noticeable in the lower extremities.

Treatment of Poisoning.—The patient should be kept in a recumbent position, the feet slightly raised. The stomach should be thoroughly emptied, keeping the patient in this position. External applications of heat should be made to raise the temperature, and diffusible stimulants, such as alcohol and aromatic spirit of ammonia, should be given; strychnin, atropin, and digitalis may be hypodermically administered for their effect upon the cardiac and respiratory centers; and, if necessary, artificial respiration should be employed.

Therapeutics.—Though the first effect of aconite, locally applied, is that of an irritant, it has not been discussed here because of this property; but rather for the reason that certain preparations of the drug, notably the tincture, have long been used in dental practice as a constituent of counterirritant remedies for the treatment of *apical pericementitis* and *facial neuralgia.* Combined with quinin, aconitin is recognized as one of the best internal remedies for *facial neuralgia.* A pill should be given three times a day before meals. Tincture of aconite has been extensively used to dilute the tincture of iodin for dental purposes. A favorite liniment of the author's for *nonseptic pericementitis* is: Menthol, 20 gr. (1.3 Gm.); chloroform, 1½ fl. dr. (6.0 cc.); tincture of aconite, 6½ fl. dr. (26.0 cc.). The therapeutics of aconite will be discussed more fully later.

CAMPHORA—U.S.P.

(Camphor; $C_{10}H_{16}O$.)

Camphor is a stearoptene obtained from *Cinnamomum Camphora*, a tree indigenous to Eastern and Southeastern Asia, and cultivated in Italy, California and other southern states as an ornamental tree. The drug occurs in white, translucent masses, of a tough consistence and crystalline structure, readily pulverizable in the presence of a little alcohol, ether, or chloroform. It is sparingly soluble in water, but freely soluble in alcohol, ether, chloroform, fixed and volatile oils. When camphor is triturated in about equal proportions with menthol, thymol, phenol, or chloral hydrate, a syrupy liquid results.

The average dose is 2 gr. (0.125 Gm.). The following preparations are official:

Aqua Camphoræ, U.S.P.
Linimentum Camphoræ, U.S.P. (20 per cent. in Cottonseed Oil).
Linimentum Chloroformi, U.S.P. (30 per cent. Chloroform in Soap Liniment.).
Linimentum Saponis, U.S.P. (4.5 per cent.).
Spiritus Camphoræ, U.S.P. (10 per cent.).
Tinctura Opii Camphorata, U.S.P. (Camphorated Tincture of Opium; Paregoric; 0.4 per cent.). *Dose*, 2 fl. dr. (8.0 cc.).

Physiologic Action.—Upon the unbroken skin, camphor acts as an anesthetic; but on the mucous membrane it is irritating, and in concentrated form may produce inflammation and even sloughing. In medicinal doses it acts as a carminative and antispasmodic. In large doses, it causes confusion of thought, headache, gastric irritation, a rapid feeble pulse, convulsions, and collapse.

Therapeutics.—Camphor is used as a rubefacient, circulatory stimulant, and antispasmodic. The spirit of camphor has long been a household remedy for *headache*, *syncope*, and *faintness*. It is administered by inhalation; camphorated oil (5 per cent. of camphor in olive oil) is a useful remedy in *colds* and *croup*. The liniments containing camphor, as well as the spirit, are extensively used in *sprains*, *bruises*, *muscular rheumatism*, and *neuralgia*. Prinz advocates a combination of thymol (2 parts), phenol crystals (2 parts), and camphor (1 part), called *thymocamphen*, as an anodyne in *root-canal treatment*. Phenol-camphor (equal parts of phenol and camphor) is also used by many as an anodyne dressing for the same purpose. Camphor is a constituent of the author's *phenol compound*, see page 60. Here the causticity of the phenol is reduced by the camphor and menthol without impairing its other valuable properties. In *acute coryza*, Stevens recommends adding a teaspoonful of powdered camphor to a tumbler of hot water, and inhaling the fumes. A more efficient way of using camphor for this purpose is to saturate a small pledget of cotton with spirit of camphor and place it in the anterior part of the nostril. By this means every breath drawn in goes laden with the drug and the secretions of the nasal passages soon become saturated with camphor—thus the germs causing the *coryza* are retarded in their activity or killed. There are also on the market preparations consisting of absorbent cotton, impregnated with camphor, menthol, phenol, methyl salicylate, eucalyptol, and other drugs of this character. These preparations

are called by various names as "Coryza Wool" etc. They form a convenient and practical method of using these agents in the treatment of *catarrhal conditions* of the nose and throat, and in *hay fever*.

EMOLLIENTS, DEMULCENTS, AND PROTECTIVES

Emollients are substances of a fatty nature which soften and relax the tissue to which they are applied, and at the same time shield the part from external irritation.

The most important emollients are:

- Glycerin.
- Soap Liniment.
- Starch.
- Hot Fomentations.
- Poultices:
  - Linseed Meal.
  - Oatmeal.
  - Bran.
  - Bread.
  - Flour.
  - Figs, etc.
- Fats and Oils:
  - Lard.
  - Olive Oil.
  - Almond Oil.
  - Linseed Oil.
  - Cottonseed Oil.
  - Lanolin.
  - Petrolatum.
  - Paraffin.
  - Cacao Butter.
  - Wax.

Demulcents are substances largely of a mucilaginous character which soothe and protect the tissues to which they are applied. The important demulcents are:

- Acacia.
- Tragacanth.
- Licorice Root.
- Flax Seed.
- Marshmallow.
- White of Egg.
- Sassafras Pith.
- Slippery Elm.

Protectives are agents used to mechanically cover and protect injured or diseased surfaces from extraneous influences, as air, water, bacteria, etc. Some protectives, besides affording mechanical protection to the part, also absorb moisture or fluids by capillary attraction. The so-called *dusting powders* and *fixed dressings* are included in this group. The chief protectives are:

- Collodion.
- Solution of Gutta-percha.
- Court Plaster.
- Charcoal.*
- Animal Charcoal.*
- Purified Cotton.
- Talc.
- Kaolin.
- Lycopodium.
- Zinc Oxid.*
- Chalk.*
- Magnesium Carbonate.*

"Emollient" and "demulcent" are largely interchangeable terms, and no distinct division between the substances used as such can be made. The emollient, demulcent, and protective agents will, there-

fore, be discussed here without reference to the three subdivisions into which they have been grouped.

GLYCERINUM—U.S.P.

(Glycerin; $C_3H_5(OH)_3$.)

Glycerin is a syrupy liquid obtained by the decomposition of fats and fixed oils. It is clear, colorless, without odor, of a sweetish, warm taste, and when exposed to the air slowly absorbs moisture. Freely soluble in water and alcohol, but insoluble in ether, chloroform, and oils. Chemically considered, it is an alcohol. Average dose is 1 fl. dr. (4.0 cc.). The following preparations are official:

Gelatinum Glycerinatum, U.S.P. (equal parts of Gelatin and Glycerin).
Glyceritum Acidi Tannici, U.S.P. (20 per cent. Tannic Acid).
Glyceritum Amyli, U.S.P. (Starch, 10; Water, 10; Glycerin, 8).
Glyceritum Boroglycerini, U.S.P. (50 per cent. of Boroglycerin).
Glyceritum Phenolis, U.S.P. (20 per cent. of Phenol).
Suppositoria Glycerini, U.S.P. (each Suppository contains 45 gr.–3.0 Gm. of Glycerin gelatinized by means of a Sodium Soap).
Cataplasma Koalini, U.S.P. VIII. (Kaolin, 57.7 parts; Glycerin, 37.5 parts; Boric Acid, 4.5 parts; Methyl Salicylate, 2 parts; Thymol and Oil of Peppermint, each ½ part).

Glycerin is also a constituent of many extracts and fluid extracts, added largely to preserve the preparations.

Physiologic Action.—When glycerin is applied to sensitive skin or mucous membrane, it has a tendency to irritate, due to the abstraction of water from the tissues. Taken internally, in large doses, glycerin acts as a cathartic, its action here probably being due also to its hygroscopic property. It is antiseptic in that it inhibits, to an extent, microorganic growth. Authorities differ as to whether or not glycerin in moderate doses acts as a food.

Therapeutics.—Externally applied, glycerin is an efficient and popular emollient. For *chapped hands* and *after shaving* the following lotion is valuable: Witch-hazel and bay-rum, each 1 fl. oz. (30.0 cc.); glycerin, 1 fl. oz. (30.0 cc.); borax, ½ dr. (2.0 Gm.). The formerly official cataplasm of kaolin, applied hot, is an excellent substitute for ordinary poultices where the latter are indicated. In *inflammatory disease of the mouth, throat, and nose*, glycerin is used to advantage as a vehicle for other drugs.

Glycerite of boroglycerin is a constituent of many *antiseptic mouth-washes;* and glycerite of tannic acid may be added, ½ fl. dr. to the fl. oz. (2.0 cc.–30.0 cc.), to mouth-washes to add astringency. Glycerite of tannic acid may also be applied to *flabby* and *inflamed gums*. Glycerin is a constituent of the author's "pyorrhea astringent" (see p. 514). It not only depletes the engorged capillaries, but also serves to spread the drugs contained therein over the entire surface.

Internally it is largely employed in *habitual constipation*. Here the official suppository may be employed.

Incompatibles.—Powerful oxidizing agents, like sodium dioxid, chromic acid, and potassium permanganate, explode with glycerin.

AMYLUM—U.S.P.

(Starch; $C_6H_{10}O_5$.)

Starch is a white powder, or masses, obtained from the fecula of the *seed* of *Zea Mays*, or Indian corn. Wheat starch (flour) and rice starch are also used in therapeutics. It is insoluble in water; soluble in boiling water. There is only one official preparation:

Glyceritum Amyli, U.S.P. (10 per cent.).

Therapeutics.—Starch is used externally in the form of dusting powders or "pastes" as protective applications. It is an antidote for *iodin poisoning*, the insoluble starch iodid being formed.

In pharmacy the glycerite of amyl is used as an excipient for making pill-masses of certain drugs.

OLEUM OLIVÆ—U.S.P.

(Olive Oil; Sweet Oil.)

Olive oil is a fixed oil expressed from the *ripe fruit* of *Olea europea*, a rather small tree indigenous to Western Asia, but cultivated in several countries, including the southern part of the United States, especially California. The oil is a pale yellow or light greenish-yellow liquid, of a characteristic odor, and an oleaginous taste. It should be kept in well-stoppered bottles, in a cool place. The average dose is 1 fl. oz. (30.0 cc.).

Physiologic Action and Therapeutics.—Olive oil is a bland and agreeable oil, and is used extensively as an emollient and demulcent. It is readily absorbed from the skin and mucous membrane, and with phenol (5 per cent.) it makes a soothing, protective application for superficial *wounds, bruises, burns, insect bites, stings, etc.* Camphorated olive oil (camphor 5 per cent.) is a useful remedy to rub on the throat and chest in cases of *colds* and *croup* in children.

In cases of *poisoning from corrosive irritating drugs*, olive oil is a valuable demulcent, unless the poison be soluble in an oil, in which case any fat or oil is contraindicated, as it would tend to hasten the absorption of the poison. Internally administered, olive oil is not only demulcent, but possesses marked nutritive and laxative properties. It is often taken in wines and liquors for its nutritive value.

LINUM—U.S.P.

(Linseed; Flaxseed.)

Linseed is the *ground seed* of *Linum usitatissimum*, or common flax, which is cultivated in all temperate countries. Its chief ingredients are a fixed oil and a mucilaginous principle. The oil (Oleum Lini, U.S.P.) is official, and enters as an essential constituent into the following preparations:

Linimentum Calcis, U.S.P. (Carron Oil.)
Liquor Cresolis Compositus, U.S.P.

Physiologic Action and Therapeutics.—An infusion or tea of flaxseed makes an excellent *demulcent drink*. The ground flaxseed is probably used for the ordinary poultice *in deep-seated inflammations* more than any other substance. The oil is similar to olive oil in its action and uses. Mixed with an equal quantity of lime-water, it makes the official linimentum calcis, commonly called Carron Oil, an excellent remedy for the treatment of *burns*. It enters as an essential constituent into *soft soap*, which is official (Sapo Mollis, U.S.P.); as is also the *liniment of soft soap* (Linimentum Saponis Mollis, U.S.P.). The liniment of soft soap, called also tincture of green soap, should be in every dental office, and used frequently on the *hands for detergent purposes*.

OLEUM GOSSYPII SEMINIS—U.S.P.

(Cottonseed Oil.)

Cottonseed oil is a fixed oil obtained from the *seed* of cultivated varieties of *Gossypium herbaceum*. It occurs as a pale yellow, oily liquid, odorless or nearly odorless, and having a bland taste. It is slightly soluble in alcohol; miscible with ether, chloroform, and petrolatum.

Physiologic Action and Therapeutics.—Cottonseed oil is used for its emollient and soothing properties. It took the place of linseed oil in the U.S.P. IX in the manufacture of soft soap. It is also used as a substitute for almond and olive oil, and enters into the composition of many liniments.

ADEPS LANÆ—U.S.P.

(Lanolin; Wool Fat.)

Lanolin, or **wool fat,** is the *purified fat* of the *wool* of sheep, freed from water. It is a yellowish-white, unctuous substance, having a faint peculiar odor. The Pharmacopeia also recognized a wool fat which contains about 30 per cent. of water (Adeps Lanæ Hydrosus, U.S.P.).

Therapeutics.—Lanolin is extensively used as a vehicle for ointments. It is bland and unirritating, does not become rancid, and has the distinct advantage of being miscible with twice its weight of water without losing its ointment-like character. With this vehicle, therefore, aqueous substances may be made into ointments. It is used as the vehicle for *devitalizing pastes* for the dental pulp. The hydrous wool fat, in pharmacy, is used as a constituent in many of the official ointments. It possesses the advantage over many vehicles used for ointments in that it is rapidly absorbed by the skin, thus carrying with it the medicaments contained therein.

PETROLATUM—U.S.P.

(Petroleum Jelly; Vaselin.)

Petrolatum is a mixture of hydrocarbons, chiefly of the methane series, obtained by distilling off the more volatile portions of petroleum and purifying the residue. The melting-point should be between 45° and 48°C. Three forms are official: Petrolatum, U.S.P. (ordinary petrolatum), a yellowish, ointment-like mass; Petrolatum Album, U.S.P. (white petrolatum), a white ointment-like mass, and Petrolatum Liquidum, U.S.P. (liquid petroleum), a clear, colorless, oily liquid. The latter is also called *Liquid vaselin* and is known by such trade names as *petronol* and *albolin*.

Therapeutics.—Petrolatum is bland and unirritating, and is extensively used as an emollient and protective dressing. It is largely substituted for benzolated lard in ointments. Phenolized vaselin (3 per cent. phenol) is a household remedy for *burns*, *bruises*, and other *excoriations*. An ointment made from orthoform (40 parts) and europhen (60 parts), with liquid vaselin as the vehicle, is a specific for pain following the *extraction of teeth* where the alveolar process has been exposed; it acts here also as an emollient and protective. Liquid vaselin containing 2 per cent. of menthol is an excellent emollient to be used as a spray in *acute coryza*.

PARAFFINUM—U.S.P.

(Paraffin.)

Paraffin should be discussed in connection with *petrolatum*. It is a mixture of solid hydrocarbons obtained from the same source. It is a white solid, and should melt between 51.6° and 57.2° C.

Therapeutics.—Gersung, in 1900, recommended the subcutaneous and submucous injection of paraffin for the correction of various defects and for cosmetic purposes. Beck, of Chicago, has employed the method quite extensively for the correction of nasal deformities; and paraffin has also been injected about the jaws with excellent results in cases of *necrosis* and other *diseases where bone tissue has been lost or removed*. The paraffin should be sterilized by boiling and must be injected with a specially prepared syringe while warm and semisolid. This substance when so injected is not absorbed, but finally becomes encapsulated. Paraffin has also been used for filling root-canals. It affords the protection from moisture necessary when filling teeth with "plastic porcelain," or the various silicate cements on the market; and may also be used to protect the enamel of the crown of the tooth when employing acids in the canal.

ACACIA—U.S.P.

(Gum Arabic.)

Acacia is a *gummy exudation* obtained from *Acacia Senegal*, and other species of *Acacia*, a small tree, deeply and firmly rooted, growing in India, Africa, and other countries. It is soluble in water. The following preparation is official:

Mucilago Acaciæ, U.S.P. *Dose*, freely.
Syrupus Acaciæ, U.S.P. IX. *Dose*, freely.

Therapeutics.—Acacia is used in therapeutics chiefly for its demulcent property. The mucilage may be further diluted with water and administered freely in cases of *poisoning from corrosive drugs*. In pharmacy it is the *emulsifying agent* generally employed in making emulsions of oleaginous drugs; it is also used in pills and lozenges for holding together the active ingredients.

Incompatibles.—It is incompatible with alcohol, ferric salts, and borax.

TRAGACANTHA—U.S.P.

(Tragacanth.)

Tragacanth is a *gummy exudation* obtained from *Astragalus gummifer*, a small shrub growing in Western Asia. This gum differs

from acacia in that it does not dissolve in water, but swells up in it and forms a gelatinous mass. The official preparation is:

Mucilago Tragacanthæ, U.S.P.

Therapeutics.—Though possessing demulcent properties, it is impracticable to use it as such on account of its insolubility. The mucilage of tragacanth may be used as an emollient in *chapped hands* and other *skin lesions*. In pharmacy it is used for suspending resinous and oleaginous drugs in water; it also enters into most of the official troches.

GLYCYRRHIZA—U.S.P.

(Licorice Root.)

Glycyrrhiza is the dried *rhizome* and *root* of *Glycyrrhiza glabra*, or *Glycyrrhiza glandulifera*, a perennial herb growing in the countries lying on the northern and southern shores of the Mediterranean Sea; also cultivated in England and the United States. It contains a glucosid, *glycyrrhizin*, to which is due its sweetish taste; it also contains an acrid resin, starch and gum. The following preparations of licorice are official:

Elixir Glycyrrhizæ (from Fluidextract), U.S.P. *Dose*, freely.
Fluidextractum Glycyrrhizæ, U.S.P. *Dose*, 15–60 min. (1.0–4.0 cc.).
Extractum Glycyrrhizæ, U.S.P. *Dose*, freely.
Extractum Glycyrrhizæ Purum, U.S.P. *Dose*, freely.
Mistura Glycyrrhizæ Composita, U.S.P. *Dose*, 1–4 fl. dr. (4.0–16.0 cc.).
Pulvis Glycyrrhizæ Compositus, U.S.P. *Dose*, ½–2 dr. (2.0–8.0 Gm.).
Syrupus Glycyrrhizæ, N. F.). *Dose*, freely.

Physiologic Action and Therapeutics.—Licorice root is demulcent and slightly laxative, and when chewed increases the flow of saliva. It slightly stimulates and favors the secretion of mucus in the respiratory passages. It is a popular remedy for *cough*, *sore throat*, and *hoarseness*. It is found in many of the pharmaceutic preparations, and may be used to advantage in masking the taste of nauseating drugs. The official fluid extract, the extract, and the syrup (N. F.) are largely used for this latter purpose.

ALTHÆA—U.S.P.

(Marshmallow Root.)

Marshmallow is the *dried root* of *Althæa officinalis*, a perennial herb growing in most countries with a temperate climate. Its chief constituents are mucilage, sugar, and starch.

Physiologic Action and Therapeutics.—Marshmallow is emollient, demulcent, and protective, and may be employed as such in all *irritable* and *inflamed conditions* of the mucous membrane and skin.

SASSAFRAS MEDULLA (Nonofficial)

(Sassafras Pith.)

Sassafras is the *dried pith* obtained from the branches of *Sassafras variifolium*, a tree indigenous to North America. Both the drug and mucilage of sassafras were official in the U.S.P. VIII.

Physiologic Action and Therapeutics.—Mucilage of sassafras pith is a pleasant demulcent, and may be used wherever such is indicated. An infusion or tea made from the bark of the root of the sassafras tree has long been a domestic remedy as a "spring tonic."

ULMUS—U.S.P.

(Slippery Elm.)

Slippery elm is the *dried inner bark* of *Ulmus fulva*, a large tree growing in the United States and Canada. It contains much mucilaginous matter.

Physiologic Action and Therapeutics.—The mucilage of elm, formerly official, is a decided demulcent, and is supposed to possess nutritive properties. It is pleasant to the taste, and generally does not disturb the stomach. It is especially useful after *washing out the stomach* for any purpose. In the form of troches (elm lozenges), it is useful as a soothing agent in *irritated* or *sore throat*.

COLLODIUM—U.S.P.

(Collodion.)

Collodion is a solution of pyroxylin, or gun cotton, 4, in ether 75, and alcohol 25 parts. It is a colorless, syrupy liquid, highly inflammable, and having a strong ethereal odor. The following preparation is official:

Collodium Flexile, U.S.P.
Collodium Cantharidatum, U.S.P. IX. (Blistering Collodion; Cantharides, 60 per cent.).

Therapeutics.—When applied to the skin, collodion quickly dries and forms a thin film, which not only protects an exposed part, but produces slight compression. It therefore makes an excellent protective for *aseptic wounds*, *fissures*, and *punctures*. This agent affords

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an efficient means of securing neat antiseptic dressings on dentists' hands which may be *abraded* or *punctured* by instruments. The wound, if necessary, can be cauterized with phenol or silver nitrate, and then covered with an antiseptic powder like europhen or boric acid; this should be covered with absorbent cotton and the dressing retained with collodion. Thus treated, the wound is well protected and should heal by first intention. The flexible collodion cracks less readily than the plain collodion, and should always be employed.

Styptic collodion was formerly official and contained 20 per cent. of tannic acid. When applied to small wounds, like *cold-sores* on the lip, it will check capillary oozing. Cantharidal or blistering collodion, formerly official, may be used as a counterirritant in *pericemental inflammations* and *neuralgias*.

Gutta-perchæ (nonofficial).—Gutta-percha is a *milky, concrete exudation,* occurring in several species of the gutta tree, which is indigenous to the Malay Archipelago, Sulu Islands, and Java; recently it was learned that the gutta tree grows abundantly in the Philippine Islands. When pure, gutta-percha has a specific coloring between pink and grayish-white. Single pieces are not adhesive at ordinary temperatures, but heated slightly and pressed together the pieces adhere and cannot be separated. Gutta-percha is insoluble in water and alcohol, but soluble in chloroform, eucalyptol, and cineol.

Therapeutics.—Gutta-percha dissolved in chloroform may be used as a protective for *small wounds.* It has also been employed as a means of retaining antiseptic and other dressings in the canals of teeth. For this purpose it does not exclude the bacteria-laden saliva, and should be discarded. The solution, known as *chloropercha*, has long been successfully used in moistening the dried canal previous to filling with a gutta-percha cone. The author suggests heating the white base-plate gutta-percha in eucalyptol (see p. 473), when a thick, creamy solution results, which becomes a soft solid when cold. This preparation is used in filling root-canals, as will be explained in Practical Therapeutics. Cochran suggests making a saturated solution of thymol in eucalyptol, and after cutting the gutta-percha with chloroform mixing the two solutions, permitting the chloroform to evaporate, when a soft solid results which is used in filling root-canals.

TALCUM PURIFICATUM—U.S.P.

(Purified Talc; Magnesium Silicate; Soapstone.)

Purified talc is a native, hydrous *magnesium silicate*, and occurs as a very fine, white, or grayish-white powder, which adheres to the

skin. It feels greasy to the touch, hence it is commonly called *soapstone*. The Pharmacopeia suggests using purified talc in the preparation of essential oil waters.

Therapeutics.—Finely powdered talc is employed as a dusting powder in inflammatory diseases of the skin, such as *acute erythematous eczema*. A useful formula is: Pulverized talc, 4 dr. (16.0 Gm.); zinc oxid, 3 dr. (12.0 Gm.); boric acid, 1 dr. (4.0 Gm.). This powder is also useful in *chafing*. Many of the commercial talcum powders contain talc and boric acid in varying proportions. Talc, or soapstone, is used in dentistry also to coat the model so that it will draw nicely from the moulding sand in making a metal die.

KAOLINUM (Nonofficial)

(Fuller's Earth; Hydrated Aluminum Silicate.)

Kaolin is a native *aluminum silicate*, occurring as a soft, white, or yellowish-white powder, odorless, and having an earthy or clay-like taste. It is insoluble in water, but becomes unctuous when moist. It is a very pure clay, having the chemic formula, $H_2Al_2Si_2O_8.H_2O$.

Therapeutics.—The cataplasm, formerly official, is used as a poultice, applied hot, in *mild local infections* about the face and jaws. Kaolin is also used in dusting powders, and is a constituent of *porcelain body*. In pharmacy it is used in pills containing easily reduced drugs, like silver nitrate and potassium permanganate, which cannot be mixed with the ordinary pill excipients.

LYCOPODIUM—U.S.P.

Lycopodium is the *spores* of *Lycopodium clavatum* and other species of *Lycopodium*, mosses growing in nearly all temperate countries. It is a fine powder, pale yellow in color, very mobile, nearly inodorous, tasteless, floats upon water and is not wetted by it, and burns quickly when thrown into a flame.

Therapeutics.—Lycopodium is employed in therapeutics as a protective. It possesses great absorbent power for oils, which, together with its dryness and lightness, renders it an excellent dusting-powder for superficial *ulcers*, *eczema*, etc. In dentistry it is also used, like soapstone, for coating models in making dies; and in pharmacy it is employed to prevent the adhesion of newly-made pills and suppositories.

In the discussion of drugs thus far, the author has endeavored to group them, as far as was possible, into local and general remedies. Those which have been considered are employed largely in therapeutics for their *local effects* upon the skin and mucous membranes of the respiratory and alimentary passages. The consideration of the next group, *local anesthetics*, will naturally lead us into the discussion of *general anesthetics*, and from then on general remedies will be considered.

ANESTHETICS

Anesthetics have been elsewhere defined as agents which temporarily destroy sensation. They are subdivided into two classes: (1) Those which produce *local anesthesia;* and (2) those which produce *general anesthesia*. By local anesthesia is meant the abolition of sensibility to *pain* in a part; general anesthesia means the abolition of all sensibility, including unconsciousness. In the administration of general anesthetics, the patients experience a stage where they are *insensible to pain*, though not unconscious. This condition is known as *analgesia*, which means the absence of sensibility to pain. Agents which produce the condition, whether general anesthetics, like *nitrous oxid*, *chloroform* or *ether*, or other drugs, such as *opium*, the coal-tar derivatives—*antipyrin*, *acetanilid*, and *acetphenetidin* (*phenacetin*)—the *bromids*, *chloral*, etc., are called *analgesics*. Closely associated with these drugs is the term *anodyne*, which means an agent that relieves *pain*. An anodyne effect presupposes the presence of pain, an analgesic effect does not; it simply means that pain cannot be experienced. Many drugs possess local anodyne properties, such as many *volatile oils*, *phenol*, *cresol*, etc.

LOCAL ANESTHETICS

Local anesthetic agents may be conveniently subdivided into two classes, according to the mode of action by which the anesthetic effect of the drug is produced.

1. **Refrigerant.**—Those agents which produce a degree of *cold* by the abstraction of heat from the part to which they are applied, even to the point of freezing the tissue.

2. **Paralyzant.**—Those agents which, when applied locally, have a direct paralyzant action upon the sensory nerve terminals.

Refrigerant.	*Paralyzant.*
Ethyl Chlorid Spray.	Cocain.
Ether Spray.	Tropacocain.

Rhigolene Spray.	Eucain.
Ice.	Procain (Novocain).
	Neothesin.
	Chloretone.
	Orthoform.
	Benzocain (Anesthesin).

ÆTHYLIS CHLORIDUM—U.S.P.

(Ethyl Chlorid; Kelene; C_2H_5Cl.)

Ethyl chlorid is prepared by the action of hydrochloric acid gas upon absolute ethyl alcohol, the hydroxyl radical in the latter being replaced by chlorin. It occurs as a colorless, extremely volatile liquid, having an odor resembling that of chloroform and a burning taste. The vapor is highly inflammable, *and it should not be used near a gas-flame or burning alcohol-lamp.*

Physiologic Action.—Applied locally by means of a spray, ethyl chlorid acts as a refrigerant local anesthetic, the tissues soon becoming white and superficially frozen from the abstraction of heat.

The drug may be inhaled from gauze or a specially devised inhaler which is adjusted to the face, when it acts as a general anesthetic. The anesthesia is usually accompanied by a fall of arterial pressure and a gradual decrease in the pulse-rate, due in all probability to a direct action upon the heart. The patient becomes anesthetized, as a rule, in from 1 to 3 minutes, and from 1–2 fl. dr. (4 0–8.0 cc.) of the drug being required, depending upon the patient. Its action is rapid and unirritating to the mucous membrane of the respiratory passages; there is an absence of choking sensation or cyanosis; and but rarely does nausea or vomiting follow. The recovery is generally complete in from 2 to 5 minutes.

Therapeutics.—Ethyl chlorid is usually sold in small metallic or glass tubes, provided with a lever-spring or screw top. When the lever is depressed or the screw released, the liquid is expelled as a spray by the heat of the hand. This drug is a safe and convenient local anesthetic for *minor operations* requiring but a single incision, as in the lancing of *abscesses, boils,* etc., or for the *extraction of loose teeth.* Its local anesthetic action is not sufficiently profound to permit the painless extraction of firmly attached teeth. There is very little danger attending the local use of the drug from inhalation.

The drug may be used as a general anesthetic for *minor surgical operations* necessitating the administration of a general anesthetic. Ethyl chlorid is a constituent of many commercial products sold for general anesthetic purposes, among which may be mentioned *somnoform, narcotile,* etc.

As a general anesthetic, ethyl chlorid has the one advantage over nitrous oxid, or nitrous oxid and oxygen, of not requiring a cumbersome apparatus for its administration, but its safety cannot be compared with that of nitrous oxid. Though the drug has only been used a few years as a general anesthetic, quite a number of deaths from its use have been reported.

Ether Spray.—Ether, or ether and alcohol, in the form of a spray, has been suggested as a means of *desensitizing dentin*. It acts as a refrigerant local anesthetic.

Rhigolene Spray.—Rhigolene is an unofficial distillate of petroleum. It may be used as a spray for the same purpose as ether, but has no advantages over the latter.

Ice.—Ice, or the ice and salt mixture, was probably the first of all local anesthetics. Though its use is largely superseded, especially in the mouth, by the volatile liquids, like ether and ethyl chlorid, it still has a place of usefulness upon accessible surfaces.

An ice-poultice may be made by sewing up tightly in rubber cloth crushed ice mixed with salt and sawdust, bran, or ground flaxseed. Local applications of cold in this manner abstract heat from the part, lessen the sensibility of the peripheral nerve-filaments, cause constriction of the blood-vessels traversing the tissues exposed to the cold, and by reflex action affect the vascularity of the parts subjacent to the site of application.

COCA (Nonofficial)

Coca is the *dried leaves* of *Erythroxylon coca*, a plant growing in the mountainous regions of Peru, Bolivia, and other South American states. It contains a number of alkaloids, the most important being *cocain*, which is official both as the alkaloid and alkaloidal salt under the titles, respectively, *Cocaina* and *Cocainæ Hydrochloridum*.

The general rule adopted by the United States Pharmacopeia in the nomenclature of articles of botanical origin is for the Latin title to be the *genus* name of the plant and not the species. Coca, which was official in the U.S.P. VIII, is a notable exception to this rule; for instead of calling this article Erythroxylon it was officially designated Coca. While the early generic names of plants were selected rather arbitrarily, the differentiation of their species is almost invariable indicated in their specific names; yet some of the native plant names lead to great confusion. Students frequently confuse the names cocoa (cacao), coco (nut), and coca, three separate and distinct plants. When Von Humboldt discovered the chocolate nut he

named it Theobroma (meaning God's drink) and cacao, after the native Indian name; but it has always been confused, because of the similarity of names, with the Cocos nucifera, the milk-bearing cocoa-nut; and by many to-day the oil of theobroma is called cocoa-butter instead of cacao. It should be remembered that *coca* is the name for the plant, from the leaves of which that valuable alkaloid, *cocain* is obtained. There are now no official preparations of this drug.

COCAINA—U.S.P.

(Cocain; $C_{17}H_{21}NO_4$.)

Cocain occurs in the form of colorless, prismatic crystals, having the bitter taste characteristic of all alkaloids, and producing on the tongue a temporary numbness. It is sparingly soluble in water (1–600 parts), much more so in alcohol (1–6.5 parts), more readily in both when warm, in ether (1–3.5), and in the oils (about 1–12). The average dose is about ¼ gr. (0.016 Gm.).

COCAINÆ HYDROCHLORIDUM—U.S.P.

(Cocain Hydrochlorid; $C_{17}H_{21}NO_4.HCl$.)

Cocain hydrochlorid, called previous to the U.S.P. of 1900 cocain hydrochlorate, occurs in the form of colorless prisms, lustrous leaflets or flakes, or crystalline powder. This alkaloidal salt, like the alkaloid itself, has a bitter taste, and leaves a temporary numbness on the tongue. It is freely soluble in water (1–0.4 part), somewhat less so in alcohol (1–3.2 parts); soluble in glycerin and insoluble in ether and oils.

The amount to be injected hypodermically at one time should not exceed ¼ to ½ gr. (0.016–0.03 Gm.).

Brief History.—It may be stated as a matter of history that the introduction of cocain to the medical and dental world was due to Koller, of Vienna, who, in 1884, reported his experiments with the drug to the Congress of German Oculists. In a few weeks cocain or the alkaloidal salt, cocain hydrochlorid, was being used as a local anesthetic all over the world. Among the men whose names should be mentioned as early investigators are the following: Hepburn, Biggs, Hall, Halsted, Rudolph Matas, J. L. Corning, and C. P. Pruyn. Hall, in 1884, demonstrated by an experiment upon himself that he could inject solutions of cocain hydrochlorid into the infraorbital nerve and anesthetize the teeth. Halsted, in the following year, 1885, and some gentlemen in South America about the same time, not knowing that Halsted was working along the

same line, demonstrated that they could inject 9 min. of a 4 per cent. solution into the inferior dental nerve as it entered the mandibular canal, and produce complete anesthesia of the gums and teeth on that side of the jaw. This method is known to-day as "nerve blocking" or *conduction anesthesia*. It was about this time that Pruyn, of Chicago, conducted a long series of experiments on dogs, and to him much credit is due for the high place which cocain occupies in dental practice to-day. In speaking of these experiments, Pruyn[1] says: "The first dog that I experimented on, and subsequently killed, made me shudder to see the poor animal in the throes of death *fighting for his breath*. It made an impression on me that has lasted ever since, and taught me that cocain should be handled very carefully, particularly when we are using it upon the human subject." Therefore, the alarming symptoms and the frequent fatalities which followed the early use of cocain caused it for a time to be barred from general use in general and dental surgery. The fact, however, that many patients objected to general anesthetics on account of the unconsciousness induced, and the further fact that every conscientious surgeon recognized that a certain amount of danger always attends the administration of general anesthetics were sufficient to cause a few men to experiment further with the drug. They diminished the strength of the solution, and gradually mastered the technic of its administration until alarming symptoms and fatalities became very infrequent.

Physiologic Action.—Whatever effects result from the administration of preparations of coca are due entirely to the alkaloids contained therein. Cocain is a typical local anesthetic of the paralyzant group. When the drug enters the circulation its first action is that of a stimulant, followed shortly by a depressant effect. It is a general protoplasmic poison, and acts deleteriously upon all kinds of tissue. It has been supposed that the drug acts more prominently upon nerve tissue, but such is not the case. It is true that its action is more discernible upon nerve tissue for the reason that this tissue is the medium of sensation and expression. When applied locally or injected beneath the mucous membrane or skin, its depressant action on the sensory nerve filaments is sufficiently profound to induce complete local anesthesia or analgesia. It is also a powerful vaso-constrictor; the ischemia produced, however, is ultimately followed by congestion.

Long before the drug was used as a medicine, the natives of South America learned that by eating the leaves of the coca plant

[1] Dental Review, Vol. 16, p. 312.

they could travel for days through the deserts without experiencing the sensation of hunger. We now know that the cocain paralyzed the nerve filaments which control the appetite.

Poisoning and Treatment.—The symptoms of *acute cocain poisoning* are rather variable. The usual manifestations are nervous

FIG. 1.—Artificial Respiration. First Movement.

excitement, followed by delirium, and later by drowsiness and stupor; nausea, vomiting, a rapid pulse, hurried and difficult respiration, dilatation of the pupils, cold sweat, blanched expression, blue lips, convulsive seizures, and finally death through asphyxia.

FIG. 2.—Artificial Respiration. Second Movement.

Individuals differ widely in their susceptibility to cocain. The local application of even moderate solutions of the drug to the nose or throat in some subjects is followed by toxic symptoms. Some have a peculiar idiosyncrasy for cocain. Cases have been authentically reported where the drug was not used, but where the patient supposed it had been, and exhibited the usual toxic symptoms in mild form.

There is no known antidote for cocain; therefore, *the treatment of poisoning* is purely symptomatic. When the symptoms are rather mild the patient should be kept in a recumbent position, the head lower than the feet, if possible (the modern dental chair makes this possible), and such stimulants given as whisky and brandy. Both of these agents have been restored to the U.S.P. X; but coming under the Volstead Act, a ruling of the Federal Department prevents them at present from being prescribed by dentists. There are no better cardiac stimulants than whisky and brandy, if properly employed. Aromatic spirit of ammonia, 15–20 min. (1.0–1.3 cc.) in a small quantity of water may be used in these cases. The irritation of the ammonia is what is desired, and it is best here not to dilute the drug too much. Spirit of ammonia or spirit of camphor may be given by inhalation. Ammonia irritates the mucous membrane, and thus reflexly or indirectly stimulates the heart. When the symptoms are more pronounced, especially when the patient is unable to swallow and a direct cardiac stimulant is required, strychnin is the drug to administer. This may be given hypodermically in the form of strychnin sulphate, the injection being made in the arm or cellular tissue of the lumbar region. One-thirtieth grain (0.0025 gm.) may be administered at a time and repeated every 15 minutes, if occasion requires, until 3 injections are made. When there is danger of respiratory failure atropin sulphate in from $\frac{1}{120}$–$\frac{1}{60}$ gr. (0.0005–0.001 Gm.) should be given. As a last resort to prevent asphyxia, artificial respiration should be performed. *Sylvester's method* is the one most commonly employed. Figs. 1 and 2 show the position of patient and attendant.

With the patient placed on his back, on a flat surface, supporting the head and shoulders with a cushion or articles of dress, all tight clothing should be loosened or removed from the neck and chest.

The movements of inspiration and expiration should regularly succeed each other at the rate of from 20 to 25 respirations per minute, or slightly in excess of the normal rate (about 18 per minute). The inspiratory period should be slightly longer than the expiratory. In all cases artificial respiration should be continued until natural respiration is established. This may require hours, and necessitate a relay of assistants. In the treatment of poisoning of any kind the operator should avoid the appearance of excitement, and remember that as long as there is life there is a chance of recovery.

Habit.—Cocain is one of the most seductive of the drugs that are taken habitually, and its effects are most disastrous. A potent cause of the cocain habit has been the frequent use of the drug in diseases of

the nose and throat. As the drug is used in dentistry there is little chance of producing the habit; yet it is very unwise to prescribe the drug to be used by the patient at home in the form of toothache remedies, mouth-washes, gargles, or nasal sprays. Cocain is one of the drugs that come under the "Federal Narcotic Law;" and whenever ordered or prescribed, it must be done on a "record blank" furnished by the United States Government. The chief symptoms of the cocain habit are emotional excitement, physical unrest, mental impairment, a disregard for morals, hallucinations, gastric disturbances, a gradual wasting away, and anemia.

Therapeutics.—There is a demand by the laity for painless dentistry, and no one drug formerly aided the dentist more in meeting this demand than cocain or its alkaloidal salt, cocain hydrochlorid. The drug was extensively used in the *painless extraction of teeth, lancing of abscesses, removal of vital dental pulps*, and many other conditions. Its use in dentistry has now been largely superceded by procain. Cocain hydrochlorid is recommended in cases of *nausea in taking impressions*. Goslee suggests using a 2 per cent. solution in an atomizer, spraying the entire palate and the uvula. A glass of tepid water should be at hand and the patient may rinse the mouth after a few seconds, to avoid swallowing the solution. The spraying process may be repeated about every five minutes until two or three applications have been made.

Cocain is also added to many arsenical preparations to control the irritating action of the arsenic trioxid. If the vehicle for such preparations is an oil, the alkaloid should always be used, as the alkaloidal salt is insoluble in oils.

The formerly official oleate (5 per cent. of the alkaloid) may be used to lessen the pain in setting crowns and bridges. This is done by applying the remedy under the margin of the gum a few minutes before setting the crown. Cocain hydrochlorid is used more extensively by the hypodermic method of administration for the painless extraction of teeth than for any other purpose in dentistry. A brief discussion, therefore, of the hypodermic use of the drug will here be considered.

Sodium chlorid has been recommended by Schleich and others as an excellent agent to be added to local anesthetic solutions for two reasons: One is that it aids in the elimination of the drug, and the other, and more important, is that with it *isotonic solutions* can be prepared with local anesthetics as the base. The action of the so-called "salt solutions" will be discussed under Cathartics (which see, p. 240). Transitory anesthesia can be produced ultimately by pres-

sure, or by simply injecting with force distilled water into the gum tissue; but distilled water being hypoisotonic to the normal fluids in the tissues, its injection causes a temporary swelling of the cells, due to osmotic action, and primary pain is produced. On the other hand, the injection of a hyperisotonic solution causes a temporary condensation of the cells, due also to osmosis, and primary pain is produced. If, therefore, isotonic solutions are employed for the purpose of inducing local anesthesia, osmotic action is avoided, and the relation of the cells to each other is not materially affected. Prinz suggests adding sodium chlorid in the following proportion in making an isotonic solution of cocain hydrochlorid:

Cocain Hydrochlorid,	5 gr. (0.3 Gm.)
Sodium Chlorid,	4 gr. (0.25 Gm.)
Distilled Water,	1 fl. oz. (30.0 cc.)

To each syringeful (30 min.–2.0 cc.) add one minim (0.065 cc.) of a 1–1000 solution of adrenalin chlorid when used. The adrenalin solution should be fresh. The technic of making the injection has been fully discussed under the Hypodermic Method (p. 27).

The principal objections to the use of cocain hydrochlorid as a local anesthetic for hypodermic use are the *sloughing of tissue* so often induced, and the *liability to poisoning*. These are important considerations and will be discussed separately.

1. Sloughing.—It has been demonstrated quite conclusively that the aseptic injection of sterile isotonic solutions of cocain hydrochlorid will not result in sloughing. Therefore, sloughing is caused either by septic infection due to the injection or to the irritation produced by the disturbed relations of the cells from the injection of solutions which are not isotonic to the fluids in the tissues. It must be understood here that the latter cause mentioned would not result in sloughing of itself, but the irritation thus produced, together with the poisoning of the protoplasm of the cells by the cocain, so lowers the normal resistance of the affected tissues that infection is more liable to follow hematogenously (through the blood stream), or from external influences, especially where there has been laceration of tissue, as in extraction. Sloughing, therefore, is due entirely to *septic infection*, either directly or indirectly from the injection or from external influences. How to guard against septic infection has been previously considered.

2. Poisoning.—Poisoning by cocain hydrochlorid is due either to the injection of an *overdose* or to *idiosyncrasy*. As has been elsewhere stated, individuals differ widely in their susceptibility to co-

cain. In the manner of its action, which has also been mentioned cocain is a peculiar drug. Its action differs with different individuals, and with the same individual at different times. There is no way of foretelling how the drug is going to affect the patient in a given case. For this reason many physicians and dentists are afraid to use cocain. However, if we master the technic of its administration and *always know the quantity injected*, there is no necessity for fright, even though toxic symptoms develop, providing, of course, that an overdose has not been injected. It is practically agreed by the best authorities that the maximum quantity of cocain hydrochlorid to be permitted to enter the circulation at one time should not exceed one-quarter of a grain (0.016 Gm.).

A great many of the ill-results attributed to cocain are due to the carelessness with which the drug is used or to shock or fright on the part of the patient for which the drug is not at all responsible. This is equally true of the hypodermic use of all local anesthetics. Many times patients collapse from shock or faint from fear or dread of the operation; and, when cocain was used these results have frequently been attributed to the drug, when, as a matter of fact, the same result might have been and often is produced when no anesthetic has been used. Whenever cocain is used about the mouth for any purpose we should always have the patient rinse the mouth to prevent swallowing any of the remedy, for the smallest quantity of cocain in the stomach will often produce nausea.

Solutions of cocain hydrochlorid should be made at the time from soluble hypodermic tablets, or should contain antiseptics to keep the solution sterile. Cresol and phenol are excellent agents to add for this purpose, and in from ½ to 1 per cent. they have no perceptible coagulant action on the albumin of the cells. Two per cent. of boric acid may also be added. The author's formula for hypodermic injection, which is practically isotonic, follows:

Cocain Hydrochlorid,	5 gr. (0.3 Gm.)
Sodium Chlorid,	1 gr. (0.06 Gm.)
Phenol (95 per cent.),	2 min. (0.13 cc.)
Peppermint Water,	1 fl. oz. (30.0 cc.)

It is well to add 1 min. (0.06 cc.) of a fresh 1–1,000 solution of adrenalin chlorid to 30 min. (2.0 cc.) of the solution at the time of injection. It should be remembered that about 23 min. (1.5 cc.) of this solution contain ¼ gr. (0.016 Gm.) of the alkaloidal salt, the maximum quantity which may safely enter the circulation at one time. This does not mean that only 23 min. can be used

at one injection; for a certain amount is lost in exhausting the air from the syringe, and a certain amount actually injected is removed before it enters the circulation, due to the subsequent hemorrhage. If the technic of injection has been mastered, one barrelful of the syringe should be amply sufficient to painlessly extract all of the teeth that should be extracted at one time, when any local anesthetic has been employed. Cocain should never be used without having at hand in a convenient and practical form the several antidotes for the drug.

There are many proprietary local anesthetic solutions on the market, and cocain formerly entered into most of them as the base of the formula. In this day of advanced dental therapeutics there is no necessity or excuse for using any proprietary remedy, the composition of which is unknown, especially when we are dealing with so powerful a drug as cocain or any other local anesthetic agent. The National Food and Drugs Act makes it obligatory for manufacturers to place on the label the amount of cocain in their preparations; and, as previously mentioned, the Anti-Narcotic Law requires practitioners to keep a record of the amount of cocain ordered and used.

Neurocain.—Neurocain is a name given to billets of cocain hydrochlorid, each containing $\frac{1}{12}$ gr. (0.005 Gm.), without excipient. The billets are $\frac{1}{8}$ in. long, $\frac{1}{20}$ in. in diameter, and very soluble in water. Cocain hydrochlorid is put up in this form expressly for dentists' use in the *removal of the pulp* by pressure anesthesia. They are convenient for this purpose, especially where it is desired to dissolve the local anesthetic in the serum of the blood in cases of *pulp exposure*. Similar preparations on the market are called **cocain points.**

Incompatibles.—Cocain hydrochlorid is incompatible with alkalies and alkaline carbonates and all alkaloidal reagents. The drug is decomposed by boiling water.

Tropacocain Hydrochlorid.—Tropacocain is an alkaloid obtained from the leaves of the Java coca plant. The hydrochlorid occurs as white needles, readily soluble in water. In its action it resembles cocain, but is less toxic and does not produce contraction of the blood-vessels. Its local anesthetic property is not sufficiently profound to merit employment as such in dental practice.

Ever since cocain has been used as a local anesthetic in dental and general surgery numerous attempts have been made by manufacturing chemists to prepare, synthetically, substitutes for the drug; among which may be mentioned the following: The eucains, acoin, nirvanin, stovain, chloretone, procain (novocain), and neothesin.

Many of these products were short-lived and failed to fill the place for which they were introduced, viz., to displace cocain as a local anesthetic. Those which proved to possess merit will here be discussed.

EUCAINA (Nonofficial)

(Eucain; $C_{12}H_{12}NO_2(CH_3)_3$.)

Eucain is a synthetic product and was placed upon the market at first as "Alpha-eucain" and "Beta-eucain," two closely allied bases, differentiated as eucain "A" and eucain "B." The former has been withdrawn from the American market, while the latter was used quite extensively in dentistry at one time as a local anesthetic in the form of *beta-eucain hydrochlorid.*

BETA-EUCAINÆ HYDROCHLORIDUM (Nonofficial)

(Beta-eucain Hydrochlorid; Eucain Hydrochlorid *B;* $C_{12}H_{12}NO_2(CH_3)_3.HCl$.)

Beta-eucain hydrochlorid occurs as a white crystalline powder, soluble in 20 to 30 parts of water at the ordinary temperature, more soluble in warm water, soluble in 25 to 30 parts of alcohol. The solutions are neutral and can be sterilized by boiling without change.

Physiologic Action and Therapeutics.—Eucain is a local anesthetic, like cocain, but weaker and devoid of the stimulating action of the latter. It does not dilate the pupil, and it differs from cocain in that it does not produce ischemia by the contraction of the blood-vessels. By some this is claimed to be an advantage, as it permits more profuse hemorrhage after operating, and thus it is supposed some of the drug is carried out of the part and does not enter the circulation. The solutions of beta-eucain hydrochlorid have the one distinct advantage of being stable even on prolonged boiling. The drug may be used in almost all cases where cocain is indicated, a 2 per cent. solution being about the strength used for the *painless extraction of teeth.*

Incompatibles.—Alkalies and their carbonates and alkaloidal reagents.

PROCAINÆ HYDROCHLORIDUM—U.S.P.

(Procain Hydrochlorid; $C_{13}H_{20}O_2N_2.HCl$.)

Procain hydrochlorid is the American name for the drug formerly called **novocain.** It is a synthetic product, and occurs in colorless needle-shaped crystals, stable in the air, readily soluble in water (1

part) and less soluble in alcohol (30 parts). The aqueous solutions of the salt are neutral and may be boiled without decomposition. The dose depends upon the purpose for which the drug is employed. Owing to its feeble toxicity it may safely be used hypodermically up to 4 gr. (0.25 Gm.) in adults.

The U.S.P. X gives tests for the identity of the drug, one of which is here given: To a solution of 0.1 Gm. of procain hydrochlorid in 5 cc. of distilled water add 3 drops of dilute sulphuric acid, followed by 5 drops of potassium permanganate T.S.: the violet color of the latter is immediately discharged (*difference from cocain hydrochlorid*).

Physiologic Action and Therapeutics.—Procain is claimed to be far less toxic than any of the synthetic substitutes for cocain; and is by far the most valuable of any yet discovered, its discovery having been made in 1905 by Einhorn, a German chemist. It is unirritating, and is frequently applied in powdered form to delicate tissues and sensitive wounds. When the drug is injected beneath the skin or mucous membrane it exerts a prompt and powerful local anesthetic action. This effect however, is not long sustained, but may be prolonged by the simultaneous injection of the suprarenal alkaloid (adrenalin or suprarenin). The employment of procain in the field of local anesthesia has contributed largely to the recent advancement along these lines in both medical and dental practice. The drug may be employed as a local anesthetic wherever cocain is indicated, and often to advantage; and should be used in preference to cocain for hypodermic administration. It is extensively employed for producing anesthesia by the *conduction* or "nerve-blocking" method. This method requires special study and technic. Excellent books on the subject, to which the reader is referred, are those of Braun-Shields, Fischer-Rietmüller, Smith, Lederer, and Thoma. In recent years many valuable articles have appeared in dental literature by Prinz, Blum, Rietmüller, Puterbaugh,[1] Schultz and others. Smith is of the opinion that a 2 per cent. solution is equal in anesthetizing power to a one-half per cent. solution of cocain, and its duration is similar.

The author's formula for local Anesthetic Solution No. 2, prepared in 1 and 2 cc. ampules is as follows:

Procain..... 2 per cent.
Adrenalin..... 1 to 25,000.
In Ringer's Solution.

[1] Dr. P. G. Puterbaugh, of Chicago, has just written a book covering the entire field of local anesthesia.

The solution is used for anesthesia by the infiltration, interosseous or conduction method; and is a sterile, nonirritating isotonic solution of procain with sufficient adrenalin to localize and intensify the anesthesia.

It has been estimated that probably 75 per cent. of the procain sold is used by dentists. Relatively little of the drug is used by the medical profession. This fact is to be regretted because it is a substance which can be employed easily and safely in thousands of operations performed at the present time under general anesthesia, or in many cases, with no anesthetic at all. Crile, of Cleveland, and Harris, of Chicago, use the drug extensively in certain operations.

Occasionally procain produces a dermatitis on the hands of dental and medical practitioners who use the drug in their practice. Fortunately this is not common; but when it does occur, it is necessary for the susceptible individual to avoid the drug. Cases have been reported by Andrews and others. Procain dermatitis begins with itching and an erythema, usually on the dorsums of the fingers, sometimes between the fingers. Small vesicles soon appear, followed by crusts. The eruption may spread to other parts of the body, and may become general. Radium, the *X*-ray and soothing lotions may be used in the treatment with success—providing the handling of the drug is discontinued.

Incompatibles.—Procain hydrochlorid is incompatible with alkalies and their carbonates and all alkaloidal reagents.

NEOTHESINÆ HYDROCHLORIDUM (Nonofficial)

(Neothesin Hydrochlorid; $(CH_3)_2N(C_2H_{11})(C_2H_5)OCO(C_6H_5).HCl$.)

Neothesin is a new synthetic product. It occurs as a white, freely soluble powder. Not administered internally.

Physiologic Action and Therapeutics.—This drug possesses marked local anesthetic properties. Experiments have shown it to be equal in anesthetizing power to cocain, one-half as toxic and more rapid in its action. It has the disadvantage of being irritating to the tissues when administered hypodermically; and is used only thus far in dentistry as a constituent of the author's "Desensitizing Paste." Here its rapid anesthetic action is of great value and its irritant effect is of no consequence. Applied directly to the exposed sensitive dentinal fibrillæ it acts quickly thereon and temporarily paralyzes the terminal ends thus exposed. It should be remembered that the drug, like cocain or other local anesthetics, thus applied

will not penetrate the softened dentin. To desensitize the dentin sufficiently deep to permit of its painless removal, agents like paraformaldehyd, from which formaldehyd gas is generated by the heat of the body, must be used. Neothesin will prevent the tooth from aching while the dentin is being desensitized.

CHLORBUTANOL (Nonofficial)

(Chloretone; $C_2Cl_3(CH_3)_2OH$.)

Chloretone is a synthetic product, and occurs as a white crystalline powder, with a camphoraceous odor and taste. It is sparingly soluble in water, but freely so in alcohol and ether. The average dose is 10 gr. (0.6 Gm.).

Physiologic Action and Therapeutics.—Chloretone, when first introduced, was claimed to have marked, local anesthetic properties and was recommended as a substitute for cocain. The local anesthetic property, however, proved to be rather feeble. The drug may be classed as a local anodyne and antiseptic, and also acts when taken internally as a somnifacient. Its use in dentistry is largely that of an antiseptic, and it is added as a preservative to solutions of organic compounds, such as cocain and adrenalin. One dram of chloretone to eight ounces of Carron oil makes an excellent application for *scalds* and *sunburns*.

ORTHOFORMUM (Nonofficial)

(Orthoform; Methyl Meta-Amino-Para-Oxybenzoate; $C_6H_3.NH_2$-$OH.COO.(CH_3)$.)

Orthoform, called also *orthoform-new*, is a synthetic compound, and is the methyl ester of meta-amino-para-oxybenzoic acid. It occurs in a fine, white, or yellowish-white, crystalline powder, neutral in reaction, odorless and tasteless. It is practically insoluble in water, but soluble in 5 or 6 parts of alcohol and in 50 parts of ether. The average dose is 10 gr. (0.6 Gm.).

Physiologic Action and Therapeutics.—Orthoform is a local anesthetic, and in its local action closely resembles cocain, but differs from the latter in that it does not penetrate the tissue on account of its insolubility. It has practically no action on the unbroken skin or mucous membrane and produces no irritation except slight corrosion about the site to which it is applied. The drug is mildly antiseptic and practically nontoxic in the usual doses. As an anodyne remedy for *painful wounds or abraded surfaces* it is an absolute specific.

Mawhinney suggests using equal parts of orthoform and europhen as a dusting powder for *burns, exposed alveolar process after extraction*, etc. It can be handled more conveniently in the mouth if a paste be made of the mixture of orthoform and europhen, using liquid petroleum as the vehicle. This is called *euroform paste.* Plain aseptic gauze may be saturated with this paste and carefully packed into *painful sockets after extraction*, covering the exposed process and lacerated tissue with the oleaginous paste. The same packing is excellent after *root amputation* and other *minor operations* about the jaws. Orthoform is a constituent of the author's *analgentum.*

Incompatibles.—Orthoform is decomposed by boiling water, and incompatible with alkalies and their carbonates.

ÆTHYLIS AMINOBENZOAS—U.S.P.

(Ethyl Aminobenzoate; Benzocain; Anesthesin; $C_6H_4.NH_2.COO(C_2H_5)$.)

Benzocain, called also **anesthesin,** is a synthetic product and was introduced as a substitute for cocain; and is the ethyl ester of 4-aminobenzoic acid. It occurs as a white, crystalline powder, odorless and tasteless, but producing a sensation of numbness when placed on the tongue; practically insoluble in cold and with difficulty soluble in hot water; soluble in six parts of alcohol, in ether, benzene, and to the amount of 2 to 3 per cent. in fatty oils. The average dose is from 5 to 8 gr. (0.3 to 0.5 Gm.).

Physiologic Action and Therapeutics.—Anesthesin acts as a local anesthetic, similar to orthoform-new, by paralyzing the sensory nerve endings. Its action is purely local and results only when applied to an abraded surface; for it does not penetrate the skin or mucous membrane. Its insolubility prevents the drug being used by hypodermic injection. It is quite extensively employed in various forms of *gastralgia*, in *ulcer* and *cancer of the stomach* for the relief of pain. Externally, it is applied as a dusting powder, either pure or diluted. It is also used in ointment and in the form of suppositories. The drug may be applied locally to any *inflammed condition of the mucous membrane*—whether in the mouth, nose, throat or other locations. Its use is purely for the control of pain, and is frequently used to *anesthetize wounded surfaces, burns, ulcerations* and *painful affections of the skin.* Like orthoform-new, it is free from any irritating or toxic action; and may be used in dental therapeutics wherever this drug is indicated.

Incompatibles.—Anesthesin is incompatible with alkalies and their carbonates, and is decomposed by prolonged heating with water.

GENERAL ANESTHETICS

The detail technic of the administration of **general anesthetics** is a topic of sufficiently great importance as to merit discussion in a separate volume by specialists in this line of work. Several excellent books covering this phase of general anesthetics are on the market.

In our discussion of the drugs grouped under this heading, the author will confine himself largely to materia medica proper. The description of the drugs, their general action, and the indication or contraindication for their use are subjects which should naturally be considered in a work of this kind. The most important general anesthetics are:

Nitrous Oxid.	Ethyl Chlorid.*
Ether.	Ethyl Bromid.
Chloroform.	Ethylene.

NITROGENII MONOXIDUM—U.S.P.

(Nitrogen Monoxid; Nitrous Oxid; Laughing Gas; N_2O.)

Nitrous oxid is a gas prepared by carefully heating, in a proper apparatus, ammonium nitrate. The gas is collected over water and purified by running it through a series of wash-bottles. It is colorless, odorless, and possesses a somewhat sweetish taste. By cold and pressure it is converted into a liquid, when it is usually placed in iron cylinders and kept for subsequent use. When the gas is administered many times daily, as with exodontists, it is best to manufacture the gas fresh each morning and store it in an ordinary gas tank for this purpose.

Physiologic Action.—Nitrous oxid is the safest known general anesthetic. The death-rate from this gas, used as an anesthetic, is less than 1 : 500,000. It is nonirritating when inhaled, but produces an increase of blood-pressure, a sense of exhilaration, ringing in the ears, and lividity of the face; in about one minute, if the gas is undiluted with oxygen, these symptoms are followed by complete unconsciousness. The muscles are not fully relaxed, and the conduct of the patient while under the influence of the gas depends largely upon the confidence the patient reposes in the anesthetist. Excitement, laughing, crying, and a pugilistic tendency, though all unconsciously, are often indulged in. It is claimed that the anesthesia

is induced by a twofold action: the temporary displacement of oxygen from the blood, and the direct influence of the gas on the central nervous system. The recovery is almost instantaneous upon the removal of the anesthetic agent. When the gas is mixed with air or pure oxygen the excitement is apt to be greater and the anesthetic effect more slowly produced.

Therapeutics.—Nitrous oxid is the ideal general anesthetic for all *minor surgical operations*. Indeed, the gas mixed in proper proportions with pure oxygen has gained a reputation for operations in *major surgery*. By this means the patient may be kept under the influence of the anesthetic for hours. Much credit is due Teter, of Cleveland, Bevan, of Chicago, and others, for developing the technic and encouraging the use of prolonged anesthesia by nitrous oxid and oxygen.

Many dental operations, like the *preparation of cavities in sensitive teeth, opening abscesses, removing partially decalcified pulp tissue*, etc., may be performed absolutely without pain under the influence of nitrous oxid and oxygen, carried to the analgesic stage. This method was quite popular for a few years past; but it has been practically superseded by the author's Desensitizing Paste for painless cavity preparation, and by conduction anesthesia for this and other dental operations.

ÆTHER—U.S.P.

(Ether; Ethyl Oxid; $(C_2H_5)_2O$.)

Ether is made by the action of sulphuric acid on ethyl alcohol. It is a transparent, colorless, mobile, and very volatile liquid, having a characteristic odor and a burning, sweetish taste. Freely soluble in alcohol, chloroform, oils, and in about ten times its volume of water. Ether is highly inflammable; its vapor, when mixed with air and ignited, explodes violently. It should be kept in well-stoppered containers, preferably in tin cans, in a cool place, away from lights or fire. The official product contains about 4 per cent. of alcohol. The average dose is 15 min. (1.0 cc.); for anesthesia about 1 fl. oz. (30.0 cc.). When ether is to be used for anesthesia it is to be dispensed only in small, well-closed containers and is not to be used for this purpose if the container has been opened longer than twenty-four hours. The following preparation was official:

Spiritus Ætheris, U.S.P. IX. *Dose*, about 1 fl. dr. (4.0 cc.).

Physiologic Action.—When applied to the skin, mucous membrane, or tooth-structure, ether produces intense cold by its rapid

evaporation, and acts as a refrigerant local anesthetic. If it is confined on soft tissue, great irritation results. When inhaled as a general anesthetic, it irritates the mucous membrane of the respiratory tract, and at first coughing, choking, and a sense of strangulation follow. These symptoms are soon overcome, and complete loss of consciousness marks the subsequent stage of anesthesia, when total relaxation supervenes, accompanied by gentle, regular breathing. The drug is eliminated chiefly by the lungs and kidneys; on the latter organs it has an irritant effect, therefore, it should be employed cautiously as a general anesthetic in cases of nephritis.

Therapeutics.—Ether is used largely as a general anesthetic, and, when thus administered for dental purposes, it had better be given by an experienced anesthetist. The ether spray is used for *obtunding sensitive dentin*. This requires a specially designed apparatus. Good results can also be immediately obtained by adjusting the rubber dam and evaporating the following remedy, applied to the cavity on a small pledget of cotton: Cocain, 20 gr. (1.3 Gm.); chloroform, 2 fl. dr. (8.0 cc.); ether, 6 fl. dr. (24.0 cc.). Ether is a valuable solvent for many substances insoluble in water, such as resins and oils.

The spray may also be used as a local anesthetic, preliminary to opening *abscesses*, but it is inferior to ethyl chlorid for this purpose.

The compound spirit of ether (formerly official and commonly called "Hoffmann's Anodyne") may be mixed with an equal volume of camphorated tincture of opium (paregoric) and given in doses of 1 fl. dr. (4.0 cc.) to check *diarrhea* in hot weather. The compound spirit of ether also is a useful remedy as an antispasmodic in children with complications of first dentition.

Contraindications.—Ether is contraindicated as a general anesthetic in cases of advanced arteriosclerosis; tuberculosis with a tendency to hemorrhage; acute and chronic diseases of the kidneys; anemia, when the hemoglobin is less than 30 per cent.; diabetes, especially when well established. Death from ether usually results from asphyxia.

CHLOROFORMUM—U.S.P.

(Chloroform; Methyl Trichlorid; $CHCl_3$.)

Chloroform is made for commercial purposes by the action of chlorin on alcohol. It is a heavy, clear, colorless, mobile, and diffusible liquid, having a characteristic odor and a burning, sweet taste. Soluble in about 200 times its volume of cold water, and in

all proportions in alcohol, ether, and oils. It is not inflammable, but its heated vapor burns, emitting a green flame and *noxious gases* are produced. For this reason care should be taken not to vaporize chloroform in the presence of a naked flame. It should be kept in amber-colored, glass-stoppered bottles, in a dark, cool place. The average dose is 5 min. (0.3 cc.); for anesthesia, about ½ fl. dr. (15.0 cc.). The following preparations are official:

Aqua Chloroformi, U.S.P. *Dose*, ½–2 fl. oz. (15.0–60.0 cc.).
Linimentum Chloroformi, U.S.P. (externally).
Spiritus Chloroformi, U.S.P. *Dose*, 20–60 min. (1.3–4.0 cc.).

Physiologic Action.—When applied to the skin or mucous membrane locally, chloroform produces a sense of coldness by its rapid evaporation. If confined, it causes redness and even vesication. When inhaled it produces general anesthesia; the phenomena observed may be grouped under three stages, and are described by Stevens[1] as follows: The first stage is characterized by excitement, muscular rigidity, and lessened sensibility (analgesia); the second by anesthesia and muscular relaxation; and the third by stertorous breathing, abolition of reflexes, profound narcosis, and absolute muscular relaxation.

The drug is eliminated practically unchanged through the lungs and kidneys, and while it irritates the latter organs its deleterious effects are less pronounced, owing to the smaller quantity necessary to induce profound anesthesia.

Therapeutics.—Chloroform is a rapid and agreeable general anesthetic. It is far more dangerous than ether, the mortality being five times greater, and should never be administered as a general anesthetic except by, or in the presence of, an experienced anesthetist.

With the patient in the upright position, chloroform may be carried to the analgesic stage, and *sensitive cavities prepared, deciduous teeth extracted*, or *abscesses lanced*. Most authorities agree, however, that the drug should not be inhaled by the patient unless in the recumbent position, and that the analgesic stage is the most dangerous. It is the safest practice to refrain from using the drug in this manner, except, perhaps, in special cases.

Chloroform is a constituent of many liniments used for counter-irritation in cases of *pericementitis* and *neuralgia*. The drug itself may be confined, and redness and even vesication follow. It has long been used as a solvent for gutta-percha, forming a solution known as *chloropercha*, used in *filling root-canals*. Like ether, the

[1] Modern Materia Medica and Therapeutics.

agent is used also as a solvent for many otherwise insoluble substances.

The liniment of chloroform has been extensively used as a stimulating remedy in *muscular rheumatism, sprains,* and *bruises.*

Indications and Contraindications.—Chloroform, though more dangerous than ether, is to be preferred to the latter as a general anesthetic in all acute inflammatory diseases of the bronchi or lungs, advanced diseases of the blood-vessels, acute and chronic diseases of the kidneys. In the extraction of teeth ether is considered the safer anesthetic; chloroform being more apt to cause cardiac paralysis reflexly by way of the superior or inferior dental (mandibular) nerve. Chloroform is contraindicated in all cardiac diseases, and if administered here must be given cautiously. Death from chloroform usually results from circulatory failure.

As has been stated, the drug is pleasant to inhale, and many individuals have the *chloroform habit.*

ÆTHYLIS BROMIDUM (Nonofficial)

(Ethyl Bromid; Hydrobromic Ether; C_2H_5Br.)

Ethyl bromid is made by heating a mixture of ethyl alcohol, sulphuric acid, and potassium bromid. When pure, it occurs as a colorless, highly volatile liquid, having an odor resembling chloroform and a sweetish taste. It is inflammable, and on exposure to air it liberates bromin and hydrobromic acid and becomes unfit for use. It should be kept in dark amber-colored bottles, tightly stoppered. The dose as a general anesthetic is from 1–6 drams (4.0–24.0 cc.), depending upon the age and condition of the patient.

Physiologic Action and Therapeutics.—As a general anesthetic, ethyl bromid somewhat resembles the action of chloroform. It may be used for *short operations,* but has nothing to recommend its employment over nitrous oxid except that it does not require cumbersome apparatus for its administration. The anesthesia is quickly and pleasantly induced and the recovery is rapid, but subsequently the patient may have general mild depression. Pain is abolished before consciousness. The respiration is paralyzed at about the same time as the reflexes, so that the zone of safety is very narrow. Tetanic spasms have occurred. Deaths caused by this drug were formerly attributed to impurities, but several have occurred when a pure article was given. It must be regarded as a very dangerous agent, especially in inexperienced hands. Ethyl bromid is a constituent of the commercial product called Somnoform, which at one time was quite extensively used in dentistry as a general anesthetic.

ÆTHYLENUM (Nonofficial)

(Ethylene.)

Ethylene is a gas, containing not less than 98 per cent. by volume of ethylene ($CH_2:CH_2$). It is supplied in compressed state in metal cylinders. For use the gas is passed into an inhalation apparatus and is then inhaled with or without admixture of oxygen.

Physiologic Action and Therapeutics.—Animal experimentation by Brown, Luckhardt, Carter and others indicate that ethylene has a direct action on the nervous system when a concentration of 90 per cent. ethylene and 10 per cent. oxygen or less is used; that the motor reflexes are abolished with this concentration, and that the phenomena produced by the undiluted gas are partly asphyxial, which effect can be removed by addition of oxygen to the ethylene itself.

On human subjects ethylene thus used has been proved to possess anesthetic and analgesic value. Deep *surgical anesthesia* is easily produced, and *analgesia* comes on readily and apparently long before surgical anesthesia is established. It has been found to be more powerful than nitrous oxid when given with oxygen, and in most instances is as effective as ether; but unlike ether it causes no respiratory irritation and does not promote salivary secretion.

The advantages claimed for ethylene over nitrous oxid for anesthesia are: Equally rapid but more pleasant induction; satisfactory relaxation without cyanosis or sweating, and rapid recovery. The disadvantages are: The odor is slightly offensive to some individuals; the gas is inflammable, and there is apparently an increased oozing of the wounds during but not following its use. No contraindications have been discovered thus far in its employment.

Generally a concentration of 90 per cent. ethylene and 10 per cent. oxygen is used for deep surgical anesthesia, though after a prolonged period of anesthesia, 80 per cent. ethylene will maintain a deep anesthetic state. To avoid accidental explosion the gas must not be brought in contact with the naked flame or an electric spark.

The gas would seem to have a wide field of usefulness in dental surgery, but to date it has not been extensively employed. Dr. John F. Christianson of Chicago, has written several articles on the use of ethylene in dentistry. For these and other articles the reader is referred to Dental Index.

Those drugs not included in this group, which possess general analgesic or anodyne properties, will be considered under other headings in the following pages.

ANTIPYRETICS

Antipyretics, called also *febrifuges*, are drugs which reduce the body temperature when abnormally high. This group includes:

Coal-tar Derivatives:
- Antipyrin.
- Acetanilid.
- Acetphenitidin.
- Pyramidon.

Cinchona, especially its alkaloid,
- Quinin.

ANTIPYRINA—U.S.P.

(Antipyrin; $C_6H_5(CH_3)_2C_3HN_2O$.)

Antipyrin is a coal-tar derivative, basic in character, obtained by the condensation of phenyl hydrazin with diacetic ether and methylization of the product. It occurs as a white, crystalline powder or scales, odorless, of a slightly bitter taste, freely soluble in water, alcohol, and chloroform. The average dose is 5 gr. (0.3 Gm.).

Physiologic Action.—Antipyrin has no action on the unbroken skin. It first irritates and then blanches mucous membranes, resulting in an analgesic effect. It may be considered a mild antiseptic, and applied locally to abraded surfaces it contracts the blood-vessels and acts as a mild styptic. Internally administered, it reduces abnormally high temperatures, as in fevers, but has practically no action in health. The drug here dilates the blood-vessels and increases perspiration, and thus heat reduction is brought about. Antipyrin differs from other anilin derivatives (acetanilid) in that it has no appreciable action upon the blood itself, and in this respect it is a much safer analgesic.

Therapeutics.—Antipyrin is a comparatively safe and useful drug in all conditions, the treatment of which calls for the relief of pain. Some authorities place it next to opium as a general analgesic. The drug may be given in powdered form or in solution for the *relief of pain of a neuralgic character*, and whenever it is desirable to *lower temperature in fever*. As an antispasmodic, it is useful in the *childhood period of tooth-eruption*, in *whooping-cough*, etc. Here it may be taken in combination with a bromid. The following may be given in teaspoonful doses, further diluted with water, to a child three years old, varying the dose according to the age: Antipyrin, 45 gr. (3.0 Gm.); sodium bromid, 1½ dr. (6.0 Gm.); glycerin, ½ fl. oz. (15.0 cc.); peppermint water, 2½ fl. oz. (75.0 cc.). In *capillary oozing after operations*, the drug may be applied locally in powdered form, or a 20 to 30 per cent. solution, which is less irritating.

Incompatibles.—Antipyrin is incompatible with tincture of iodin, mercuric and mercurous chlorid, the ferric salts in solution, phenol, chloral, beta-naphthol, sodium bicarbonate, sodium salicylate, orthoform, spirit of nitrous ether, and the salts of quinin and caffein. The wide range of incompatibles is due to the basic properties of the drug.

ACETANILIDUM—U.S.P.

(Acetanilid; Antifebrin; $C_6H_5NH.C_2H_3O$.)

Acetanilid is a coal-tar product, derived from anilin, an atom of hydrogen in the latter being replaced by the acetic acid radical, monoacetyl analin. It occurs as a white, shining, crystalline powder, without odor, of a faintly burning taste; sparingly soluble in water, freely in alcohol and chloroform, and somewhat less so in ether. The average dose is 3 gr. (0.2 Gm.). There was formerly one official preparation:

> Pulvis Acetanilidi Compositus, U.S.P. VIII (Compound Acetanilid Powder; Acetanilid, 70 parts; Caffein, 10 parts; Sodium Bicarbonate, 20 parts). *Dose*, 7½ gr. (0.5 Gm.).

Physiologic Action.—Like antipyrin, in moderate doses in health acetanilid has no perceptible effect. Internally administered in fever, the drug produces marked fall of temperature, due, in all probability, to its direct influence on the centers which regulate heat-production. Free perspiration frequently accompanies the fall of temperature. In large doses acetanilid acts as a cardiac depressant and induces blood-changes. The blood assumes a chocolate color, due to the production of methemoglobin. It is, therefore, not as safe an analgesic as antipyrin, though exerting a greater influence over the nerve centers which control pain. Applied locally to mucous membranes or abraded surfaces, the drug is nonirritating and exerts an analgesic effect by depressing the sensory nerve-endings.

Poisoning and Treatment.—The symptoms of poisoning by acetanilid are marked cyanosis, feeble breathing, pulse soft, slow, later rapid and weak, free perspiration, pupils dilated and ultimate collapse. In the *treatment of poisoning* the body temperature should be maintained by external heat and such cardiac and respiratory stimulants given as strychnin sulphate, ammonia, and atropin sulphate. In combating the cyanosed condition inhalations of pure oxygen and artificial respiration are important.

Therapeutics.—Acetanilid, judiciously employed, is a valuable drug for the relief of pain in many diseased dental conditions, such as

acute abscess, neuralgia, headache, etc. It is always best to combine the drug with a stimulant to overcome the depressant effect of acetanilid upon the heart. In the formerly official powder, caffein is added for this purpose. Harlan suggested a formula wherein whisky was added as the cardiac stimulant. It is: Acetanilid, 10 gr. (0.65 Gm.); simple syrup, ½ fl. oz. (15.0 cc.); whisky, 2 ½ fl. oz. (75.0 cc.). A ruling of the Department of the United States Government, governing thee nforcement of the Volstead Act, prevents dentists from prescribing whisky or brandy. Therefore, at present this prescription, though valuable, should not be written by dentists. The compound powder, which can be obtained in tablets, is an excellent form in which to administer the drug.

The drug may be cautiously applied locally in powdered form in the treatment of *wounds*, *burns*, *ulcers*, or other *abraded surfaces*, but is far inferior, as a local analgesic, to orthoform.

ACETPHENETIDINUM—U.S.P.

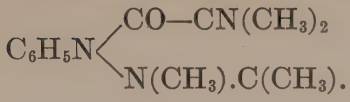
(Acetphenetidin; Phenacetin; $C_6H_4OC_2H_5.NHC_2H_3O$.)

Acetphenetidin, commonly called **phenacetin,** is a coal-tar product obtained by the action of glacial acetic acid on paraphenetidin (an anilin derivative), one atom of hydrogen in the latter being replaced by the acetic acid radical. It occurs as white, glistening, crystalline scales or fine powder, without odor or taste, sparingly soluble in water, but freely so in alcohol and glycerin. The average dose is 5 gr. (0.3 Gm.).

Physiologic Action and Therapeutics.—Internally administered, phenacetin exerts a similar action to that produced by antipyrin and acetanilid, though all authorities claim that it is far less toxic than either of these drugs. Everything considered, it is the most satisfactory of all of the coal-tar antipyretics. Probably the only objection that may be offered to its use is that it is more expensive than antipyrin or acetanilid, but when its safety is considered even this possible objection is outweighed. It may be advantageously employed in all cases where the other coal-tar analgesics have been mentioned. A useful formula is the combination of acetphenetidin and codein sulphate in the proportion of 5 gr. (0.3 Gm.) of the former to ½ gr. (0.03 Gm.) of the latter for an adult dose.

Though the actions of antipyrin, acetanilid, and acetphenetidin are similar, frequently results are obtained by the use of one of the drugs where the others have failed. The drug may be combined with the bromids with excellent results.

PYRAMIDON (Nonofficial)



Pyramidon is dimethylaminoantipyrina and differs from antipyrin in that a dimethylamino group, $N(CH_3)_2$, has replaced a hydrogen atom of the pyrazolon nucleus. It occurs in small, colorless, slightly alkaline crystals, almost tasteless; soluble in 11 parts of cold water and readily soluble in alcohol, ether and benzene. The average dose is 5 gr. (0.3 Gm.), most conveniently given in the form of tablets, a single dose usually sufficing for twenty-four hours.

Physiologic Action and Therapeutics.—Pyramidon acts as an antipyretic and general anodyne, like antipyrin, but is effective in smaller doses and the effect persists longer, though somewhat slower at the beginning. It is claimed to be comparatively free from harmful influences on the blood, heart, or kidneys. In all cases in dentistry calling for the *relief of pain* it may be given. Like other antipyretics, it should be cautiously employed in the treatment of infectious fevers.

Incompatibles.—In general the drug is incompatible with the same agents as is antipyrin. Oxidizing agents (also acacia) often produce colored solutions.

CINCHONA—U.S.P.

(Yellow Peruvian Bark; Yellow Cinchona.)

Cinchona is the *dried bark* of *Cinchona calisaya*, *Cinchona ledgeriana*, *Cinchona officinalis*, and several other species of *Cinchona*, tall evergreen trees indigenous to South America, and now cultivated in Ceylon, Java, and Jamaica. Red cinchona is also official, Cinchona Rubra, U.S.P., and is the *dried bark* of *Cinchona succirubra*. Both specimens should yield not less than 5 per cent. of total anhydrous cinchona alkaloids, of which there are several; the most important are *quinin*, *quinidin*, *cinchonin* and *cinchonidin*. The following preparations are official:

Fluidextractum Cinchonæ, U.S.P. *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).
Tinctura Cinchonæ, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Tinctura Cinchonæ Composita, U.S.P. (Huxham's Tincture; Red Cinchona, 10; Bitter Orange Peel, 8; Serpentaria, 2). *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Several of the alkaloids and their salts are also official. They are:

Quinina, U.S.P.	*Dose*, 1–10 gr. (0.06–0.65 Gm.).
Quininæ Sulphas, U.S.P.	*Dose*, 1–20 gr. (0.06–1.3 Gm.).
Quininæ Bisulphas, U.S.P. Quininæ Dihydrochloridum, U.S.P. Quininæ Hydrochloridum, U.S.P. Quininæ Hydrobromidum, U.S.P.	*Dose*, 1–15 gr. (0.06–1.0 Gm.).
Cinchonidinæ Sulphas, U.S.P.	*Dose*, 1–2.0 gr. (0.06–0.13 Gm.).
Quininæ et Ureæ Hydrochloridum.	*Dose*, hypodermic (one dose daily) 15 gr. (1.0 Gm.).

It will be observed that there is rather a wide range of dosage given for these alkaloidal salts of quinin. The reason for this is that they, like quinin itself, are given both as a tonic and antimalarial. The dose as a tonic is much smaller than for antimalarial purposes.

Inasmuch as quinin is the most important alkaloid of cinchona and represents largely its active properties, it will be the only constituent here described.

QUININA—U.S.P.

(Quinin.)

Quinin occurs as a white, flaky, amorphous or crystalline powder, odorless, and of an extremely bitter taste. It is practically insoluble in water, but is readily soluble in acidulated water, alcohol, and ether.

Physiologic Action.—Quinin acts differently upon different individuals. In large doses, and with some subjects in comparatively small doses, it causes a sense of fullness in the head, ringing in the ears, deafness, headache, and sometimes dimness of vision. This group of symptoms is included in the term *cinchonism*. The drug is absorbed chiefly from the stomach, and its action augments the secretions from the salivary and gastrointestinal glands; it, therefore, may be considered a stomachic and tonic. Through the kidneys is the principal mode of elimination. Butler[1] states that quinin has a remarkable effect upon the constituents of the blood. The ameboid movements of the white blood-corpuscles are arrested, preventing them from migrating through the capillary walls in inflammation. Full doses of the drug also diminish the white blood-corpuscles, while the red corpuscles are proportionately increased. Quinin diminishes the metabolism of the body by lessening the oxygen-carrying power of the red blood-corpuscles. Though it is doubtful that quinin ever directly caused the death of a human being, idiosyncrasies are frequently encountered. Two or 3 gr. (0.13–0.2 Gm.) have been known

[1] Text-Book of Materia Medica, Therapeutics and Pharmacology.

to produce intense cinchonism in some individuals, and quinin rashes are not uncommon. The drug also acts as an antiseptic and it is claimed to possess local anesthetic properties. Quinin and urea hydrochlorid is now being used as a local anesthetic. This is a compound of quinin hydrochlorid and urea hydrochlorid, containing approximately 60 per cent. of anhydrous quinin. When injected hypodermically or when applied locally to mucous membranes it exerts an anesthetic action similar to that of cocain, which, however, may be prolonged for several days.

Therapeutics.—Quinin has been used extensively as a domestic remedy for many ills, and most individuals know how the drug affects them. This will govern the dentist in regard to the dose to be administered in a given case. The drug is a specific for *malarial fever*, and may be given in cases of *neuralgias* associated with the teeth; especially is it indicated here in malarial regions and in the spring of the year when the climate is more or less damp. The author prefers quinin bisulphate, as it is more soluble. It should be given in gelatin capsules or cachets rather than in the dry, hard, pilular form, as the latter may pass through the stomach undissolved. Quinin dihydrochlorid, first introduced in the U.S.P. IX, is also very soluble, and its use has been proposed where concentrated solutions of quinin are wanted, as for subcutaneous injections and similar purposes. Quinin is a constituent of many bitter tonics. Quinin sulphate has been recommended for its tonic and antiseptic properties as a local application in *pyorrheal pockets*. The bitter taste of the drug makes its use here almost prohibitive.

HYPNOTICS

Hypnotics, also called *somnifacients*, are agents which induce sleep. The chief hypnotics are:

Chloral Hydrate.	Trional.
Butyl-chloral Hydrate.	Paraldehyd.
Sulphonal.	Amytal.

The Bromids.

CHLORALUM HYDRATUM—U.S.P.

(Hydrated Chloral; Chloral; $C_2HCl_3O + H_2O$.)

Hydrated chloral is obtained by the union of a molecule of water with trichloraldehyd, commonly called chloral, the latter being prepared by the action of chlorin upon alcohol, whence the name *chlor-al*. Chloral hydrate is the official preparation and the only one used in dentistry or medicine. It occurs as colorless, transparent crystals.

having an aromatic, penetrating odor, and a bitterish, caustic taste; freely soluble in water, alcohol, ether, and chloroform. It liquefies when triturated with an equal quantity of menthol, thymol, phenol, or camphor. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action.—Applied locally, chloral hydrate acts as an antiseptic, mild anesthetic and vesicant. Even when applied to the unbroken skin, it produces redness and sometimes vesication. Internally administered in therapeutic doses, the drug induces quiet sleep of a natural character. It is irritating to the stomach and had better be given after meals. The chief action of chloral hydrate is upon the nervous system, the sleep being the result of the direct influence of the drug over the cerebral cells which lessens reflex activity by depressing the motor neurons of the spinal cord. The drug has a depressant effect upon the cardiac and respiratory centers, which is an objection to its use. Attempts to modify the drug so as to make it safer have resulted in weakening its hypnotic action. It is the standard hypnotic of its class. It is eliminated principally by the kidneys.

Poisoning and Treatment.—The symptoms of *acute chloral poisoning* are sleep, deepening into coma. The pulse is feeble, thready, and irregular; temperature subnormal; respiration slow, followed by rapid shallow breathing, and ultimate collapse. Death may result from either cardiac or respiratory paralysis. In the *treatment of poisoning* the temperature should be maintained or restored by artificial heat—warm blankets, hot bottles, etc. Cardiac and respiratory stimulants, like strychnin, ammonia, atropin, and digitalis should be employed. To prevent asphyxia, inhalations of pure oxygen and artificial respiration should be resorted to early.

Therapeutics.—The principal use of chloral hydrate is to induce sleep in cases of *insomnia.* It is especially indicated when the sleeplessness results from overwork, excitement, fear, or dread. It should not be given continuously on account of the liability to form habit. As a hypnotic for insomnia resulting from pain, the drug is far inferior to opium. On account of the powerful depressant effect chloral hydrate exerts upon the motor neurons of the spinal cord, it is a valuable drug in the treatment of the various *convulsions* and *spasmodic disorders of childhood,* such as the *complications of temporary dentition, whooping-cough,* etc. Combined with potassium bromid it is considered one of the best sedatives in the treatment of the *convulsions of tetanus* and *strychnin poisoning.*

Chloral camphor, a clear, syrupy liquid, can be made by triturating equal parts of chloral hydrate and camphor. This remedy may be used as an anodyne in cases of *pulpitis,* and in *neuralgia.*

Contraindications.—The drug is contraindicated in cases of marked cardiac and respiratory weakness.

Incompatibles.—Chloral hydrate is incompatible with alkalies and strong solutions of antipyrin.

Butyl-chloral Hydrate.—This product is produced by the action of chlorin on acetic aldehyd, hydrated by the addition of water. It occurs in white, pearly scales, having a pungent odor, and an acid, disagreeable taste. It is practically insoluble in water, but freely soluble in alcohol and glycerin. The average dose is 8 gr. (0.5 gm.).

Physiologic Action and Therapeutics.—In its action, butyl-chloral hydrate resembles chloral hydrate, except that it is less powerful as a hypnotic and more analgesic. Authorities claim that the fifth or trigeminal nerve is especially susceptible to the influence of butyl-chloral hydrate, and the drug has been extensively used in the treatment of *facial neuralgia* and *migraine*. The drug is best given in the form of capsules on account of its disagreeable taste.

Incompatibles.—Butyl-chloral hydrate is incompatible with alkalies.

SULPHONMETHANUM—U.S.P.

(Sulphonmethane; Sulphonal; $(CH_3)C(SO_2C_2H_5)_2$.)

Sulphonal is a synthetic product obtained by the oxidation of a mixture of ethyl hydrosulphid and acetone (a liquid resembling ethyl alcohol in its action). It occurs as a colorless, odorless, and nearly tasteless, crystalline powder; soluble in 360 parts of cold water, in 15 parts of boiling water, and in 65 parts of cold or 2 parts boiling alcohol. The drug is stable and is not affected by strong acids or alkalies. The average dose is 12 gr. (0.75 Gm.).

Physiologic Action.—Sulphonal is a pure hypnotic, its action as such being intensified by combining it with morphin or codein. It has no depressant effect upon the heart, but, like chloral hydrate, it acts chiefly on the nervous system by depressing the cerebral cortex; its influence, however, is less than the latter drug and its action much slower, due to its insolubility in the gastric fluids. The hypnotic effect of sulphonal may not be evidenced for several hours after the administration of the drug.

Poisoning and Treatment.—The symptoms of acute sulphonal poisoning are headache, vertigo, marked cyanosis, vomiting, diarrhea, respiration shallow, pulse feeble, unconsciousness and final collapse. Some individuals who become habitual takers of this class of drugs present irregular toxic symptoms, consisting of sleepiness and stupidity, loss of appetite and muscular weakness. With some papu-

lar eruptions are not uncommon. The *treatment of acute poisoning* consists in the discontinuance of the drug; the administration of saline cathartics, and cardiac and respiratory stimulants as indicated by the symptoms present.

Therapeutics.—Sulphonal is used internally as a hypnotic. It has no other effect, and is never used externally. In *insomnia*, caused by *nervous excitement*, *grief*, or *overwork*, it is a useful hypnotic. In insomnia due to pain, it is practically worthless, unless combined with the alkaloids of opium. Sulphonal should always be given in powder or capsules or hot whisky. The compressed tablets, unless crushed, should be avoided on account of the sparing solubility of the drug. Unless the drug is in solution when administered or in such form as to facilitate solution it will enter the circulation so slowly that its effect will not be produced. To insure solution and thereby its effect it is best to dissolve the powder in hot water and drink as soon as it is cool enough to swallow. Some flavoring agent may be added to mask the taste.

SULPHONETHYLMETHANUM—U.S.P.

(Sulphonethylmethan; Trional; $C_2H_5.CH_3.C(SO_2C_2H_5)_2$.)

Trional is a synthetic product containing three ethyl radicals, where sulphonal contains but two. It occurs in colorless, lustrous, odorless, and almost tasteless, crystalline scales; soluble in 195 parts of cold water, and freely soluble in hot water, alcohol and ether. The average dose is 12 gr. (0.75 Gm.).

Physiologic Action and Therapeutics.—Trional closely resembles sulphonal in its action. Being more readily soluble, however, the drug acts more quickly and has a tendency to accumulate in the body. It is, therefore, more poisonous than sulphonal. It is best administered in a warm vehicle, such as milk, tea, or brandy. The treatment of poisoning does not differ from that of sulphonal.

PARALDEHYDUM—U.S.P.

(Paraldehyd; $C_6H_{12}O_3$.)

Paraldehyd is a synthetic product obtained by treating aldehyd with dilute sulphuric or nitric acid. It occurs as a colorless liquid, having a strong ethereal odor, and a burning, pungent taste. It is soluble in 8 parts of cold water, somewhat less so in hot water, and is miscible in all proportions with alcohol, ether, chloroform, and the oils. The average dose is 30 min. (2.0 cc.).

Physiologic Action and Therapeutics.—Paraldehyd resembles chloral hydrate in its action in that it depresses the brain and spinal

cord. It differs from the latter, however, in that its depressant action upon the heart is not nearly so marked, though it causes a noticeable fall in arterial pressure. The drug is used only internally as a hypnotic, and as such it is safe and reliable. It has the great disadvantage of a nauseating taste which is difficult to mask, and its disagreeable odor is imparted to the breath for some time after its administration. The symptoms of *poisoning* and the treatment of the same are similar to chloral hydrate. As a hypnotic in dental practice, chloral hydrate is far preferable to sulphonal, trional, or paraldehyd.

AMYTAL (Nonofficial)

Amytal is a new combination of the barbituric acid series of hypnotics. It is iso-amyl-ethyl barbituric acid and occurs as a white crystalline powder, soluble in water. The average dose is 2 gr. (0.129 Gm.).

Physiologic Action and Therapeutics.—The clinical reports relating to amytal give every indication that the new combination is a valuable addition to the list of hypnotic drugs. Its action has not been definitely determined, but most striking features regarding the action and effect of the drug have been noted clinically. These are the small doses required to produce sleep, the rapidity with which this is accomplished and the entire absence of any depression or after-effect, so that the patient wakens refreshed as from a natural sleep. Administered in from 1½ to 3 gr. (0.097–0.194 Gm.) doses its action is prompt, sleep following in from 30 to 45 minutes. The drug is recommended as a hypnotic and will prove useful in *insomnia* due to nervousness, hypertention, hyperthyroidism and mental worry, and as a sedative in *neurasthesia,* the after-treatment of *alcoholism* and *narcotism* and various mental disorders requiring a sedative or soporific effect. Amytal alone is not indicated for sleeplessnes or restlessness due to pain, but it may be advantageously combined in use with opiates thus lessening the amount of the latter required. For the patient who evidences nervousness in the dental chair due to fear or dread, a 1½ gr. (0.097 Gm.) tablet given 30 minutes before operating will prove extremely useful.

Amytal has been found to be a very valuable general anesthetic for laboratory animals and may be used either subcutaneously or intraperitoneally for this purpose. It produces a profound surgical anesthesia from which the animal recovers in good condition. The dose for animals as an anesthetic is about 0.05 Gm. per kilogram and the solution for injection may be prepared as follows:

To 1 gram of amytal add 8.85 cc. half normal sodium hydroxid and bring just to the boiling temperature with stirring to dissolve. Do not boil. Cool and dilute to 10 cc. with water and filter. Use 0.5 cc. per kilogram.

This solution precipitates after standing a few hours and should therefore be used while comparatively fresh. The anesthesia thus produced is a surgical anesthesia which lasts several hours and from which the animal recovers the following day.

Amytal is being used rather extensively in pharmacologic and physiologic laboratories and for this purpose is supplied in crystalline form.

THE BROMIDS

The **bromids** of certain metals, notably potassium, sodium, and ammonium, might well be discussed under different headings; but they are true *spinal cord depressants*, and when administered produce hypnotic influence; therefore, they will be considered here.

POTASSII BROMIDUM—U.S.P.

(Potassium Bromid; KBr.)

Potassium bromid is a salt which occurs in colorless, or white cubical crystals or granules, odorless, with a pungent, saline taste; soluble in about 1.5 parts of water and in 180 parts of alcohol. The average dose is 15 gr. (1.0 Gm.).

Physiologic Action.—The chief action of potassium bromid is on the nervous system. It depresses both the cerebrum and spinal cord. The drug is rapidly absorbed from the stomach, having been found in the urine fifteen minutes after its ingestion. Its elimination is somewhat slower than its absorption, and there is a tendency for the drug to accumulate in the body. The continued use of potassium bromid is followed by a group of symptoms, called *bromism*, chief among which are anemia, fetor of the breath, gastric disturbance, mental depression, failure of memory, abolition of sexual appetite, and muscular weakness. In the treatment of *acute poisoning*, eliminatives should be given (diuretics and cathartics), the administration of the drug should be withdrawn, and other symptoms treated as presented. No fatal case of poisoning by potassium bromid is on record.

Therapeutics.—Perhaps there is no drug which will control the nervousness due solely to the *dread of the dental chair* better than potassium bromid. The drug is especially indicated in *nervousness* caused by *fear* or *dread*. In cases of highly nervous individuals the

drug may be given in 10 gr. (0.6 Gm.) dose, after meals and well diluted, one day previous to the time of the dental operation. On account of the nauseating taste the drug should be dissolved in one of the official syrups. The compound syrup of sarsaparilla is an excellent vehicle.

Potassium bromid is one of the best drugs to control the convulsions of *epilepsy*, and is often used to advantage in the *complications of temporary dentition*. The drug is irritating to the stomach, and should always be given after meals, well diluted. It may be combined with the antipyretic drugs with excellent results.

Incompatibles.—Potassium bromid is incompatible with acids and acid salts. Certain alkaloids are precipitated from neutral solutions by the drug.

SODII BROMIDUM—U.S.P.

(Sodium Bromid; NaBr.)

Sodium bromid is a salt which occurs in colorless, or white, cubical crystals or granules, odorless, and of a saline, bitter taste; soluble in 1.7 parts of water and in 12.5 parts of alcohol. The average dose is 15 gr. (1.0 Gm.).

Physiologic Action and Therapeutics.—Sodium bromid closely resembles potassium bromid in its action. It is less irritant to the stomach and less depressant, due to the sodium *ion*. Because of this fact, it may be substituted to advantage for the potassium salt in certain cases in which a bromid is indicated. It should be given after meals, well diluted.

Incompatibles.—The same as protassium bromid.

AMMONII BROMIDUM—U.S.P.

(Ammonium Bromid; NH_4Br.)

Ammonium bromid is a salt which occurs in white crystals or as a yellowish-white powder, odorless, and having a disagreeable salty taste; soluble in 1.2 parts of water and in 12.5 parts of alcohol. The average dose is 15 gr. (1.0 Gm.).

Physiologic Action and Therapeutics.—Ammonium bromid resembles potassium bromid in its action. Like the sodium salt, it is less irritant to the stomach and less depressant to the nervous system. It may be substituted for potassium bromid in all cases calling for the administration of a bromid. It should be given after meals, well diluted.

Incompatibles.—The same as potassium bromid, also spirit of nitrous ether.

NARCOTICS

Narcotics are agents which induce stupor, and are closely related to stimulants in that the first effect of their action is generally that of an excitant and stimulant to the higher brain, to the mind, and to all of the bodily functions; this stage of their action is followed by profound sleep characterized by increasing stupor, and, if the dose has been sufficient, the second stage is followed by a third, that of coma and insensibility (narcotism) and ultimate death due to paralysis of the centers which govern respiration and other functions of life. The chief narcotics are:

Opium (and Alkaloids).	Alcohol.
Hyoscyamus.	Ether.*
Scopola.	Chloroform.*
Cannabis Indica.	Chloral Hydrate.*

Tobacco.

OPIUM—U.S.P.

Opium is the *concrete milky exudation* (*juice*) obtained by incising the unripe capsules of *Papaver somniferum*, a poppy plant indigenous to Western Asia and cultivated in Egypt, Persia, Asia Minor, and other countries. It appears in irregular cakes or lumps, having a dark brown color, a gummy consistence, a peculiar narcotic odor, and a bitter taste. With the possible exception of cinchona, opium contains more alkaloids than any other drug. The chief alkaloids, in the order of their therapeutic significance, are *morphin*, *codein*, *narcein*, *thebain*, *narcotin*, and *papaverin*. To be up to the official standard, opium, in its normal, moist condition, should yield not less than 9.5 per cent. of anhydrous morphin. The average dose is 1 gr. (0.06 Gm.). The official preparations are:

Opii Pulvis, U.S.P. (should contain not less than 10 nor more than 10.5 per cent. of anhydrous Morphin). *Dose*, ¼–2 gr. (0.016–0.13 Gm.).

Opium Granulatum, U.S.P. (10 to 10.5 per cent. of Morphin). *Dose*, ½–2 gr. (0.03–0.13 Gm.).

Tinctura Opii, U.S.P. Tinctura Opii Deodorati, U.S.P. IX (Laudanum; 10 per cent.). *Dose*, 5–20 min. (0.3–1.3 cc.).

Tinctura Opii Deodorati, U.S.P. IX (10 per cent.). *Dose*, 5–20 min. (0.3–1.3 cc.).

Tinctura Opii Camphorata, U.S.P. (Paregoric; contains Camphor, Benzoic Acid, Oil of Anise, and Powdered Opium;

4 fl. dr. (15.0 cc.) represent about 1 gr. (0.065 Gm.) of Opium). *Dose*, ½–4 fl. dr. (2.0–15.0 cc.).

Pulvis Ipecacuanhæ et Opii, U.S.P. (Dover's Powder; contains 10 per cent. of Powdered Opium; 10 per cent. of Powdered Ipecac; and 80 per cent. of Sugar of Milk). *Dose*, 5–10 gr. (0.3–0.65 Gm.).

Mistura Glycyrrhizæ Composita (from Camphorated Tincture of Opium). *Dose*, 2–3 fl. dr. (8.0–12.0 cc.).

Morphin and **codein** are the chief alkaloids of opium, and they represent the physiologic activity of the drug. The latter is official. Morphin, the alkaloid, was deleted in the U.S.P. X and is represented by its salts. It occurs in white, prismatic, shining crystals or fine needles, odorless, of a bitter taste, and sparingly soluble in water, freely so in alcohol. The average dose is ⅛ gr. (0.008 Gm.).

Codein occurs in white or nearly translucent prisms, or a crystalline powder, odorless, and having a faintly bitter taste; soluble in 120 parts of water and in 2 parts of alcohol. The average dose is ½ gr. (0.03 Gm.).

Heroin is the diacetic ester of morphin, called also diacetylmorphin. It occurs as white crystalline powder, with slightly bitter taste, insoluble in water, but freely soluble in acidulated solutions. The average dose is ⅛ gr. (0.008 Gm.).

The salts of morphin and codein are much more soluble than the alkaloids themselves, and these are generally prescribed. The following are official:

Morphinæ Hydrochloridum, U.S.P. *Dose*, ⅛–½ gr. (0.008–0.032 Gm.).

Morphinæ Sulphas, U.S.P. *Dose*, ⅛–½ gr. (0.008–0.032 Gm.).

Codeinæ Sulphas, U.S.P. *Dose*, ½–2 gr. (0.03–0.13 Gm.).

Codeinæ Phosphas, U.S.P. *Dose*, ½–2 gr. (0.03–0.13 Gm.).

Physiologic Action.—Opium is a narcotic inducing stupor, and as a result true analgesic and hypnotic effects are produced, the dominant action being due to the morphin which it contains. The drug acts principally upon the brain, which it soon depresses, causing sleep. When the dose has been moderate, a stage of excitement or exhilaration generally precedes the narcosis. In large doses opium is a powerful respiratory depressant, and in fatal cases of poisoning death usually results from paralysis of the respiratory centers.

All of the secretions, except the perspiration, are diminished by opium; the salivary glands are especially affected, causing great dryness in the mouth and consequent thirst; digestion is also impaired and constipation results.

There is a difference of opinion in regard to the local action of morphin. Stevens[1] states that morphin, applied locally, acts as a direct depressant to the sensory nerve filaments. Many pharmacologists claim that the alkaloid has little or no local action, and that to produce its effect it must enter the circulation and be carried to the brain where it depresses the central nervous system.

Opium is rapidly absorbed and is eliminated chiefly from the viscera of the stomach and intestines (gastrointestinal mucous membrane) and very little by the kidneys.

Conditions and Drugs Modifying the Action of Opium.—There are certain symptoms, diseases, and drugs which greatly modify the action of opium. Patients suffering from severe pain, as in acute alveolar abscess, neuralgia, etc., or patients having diabetes can frequently take with advantage doses which, under ordinary circumstances, would produce profound narcosis. The age and sex also modify the action of opium. Children are peculiarly susceptible to the drug on account of their sensitive nervous mechanism, and, therefore, smaller doses must be given than the age would naturally indicate. The action of opium is more pronounced on women than on men.

Patients rapidly acquire a tolerance of the drug through frequent repetition of the dose, so that habitués can often take large quantities without experiencing the usual effects.

The hypnotic action of opium is enhanced by combining it with hypnotic drugs; its anodyne influence is increased by belladonna and cocain, and its diaphoretic effects by ipecac.

Poisoning and Treatment.—It is the acute rather than the chronic poisoning by opium with which the dentist should be familiar. Unless the dose is very large, the narcotic symptoms are manifested by three distinct stages. The first is excitement or exhilaration, in which the imagination is stimulated and the feelings are exalted. This is soon followed by the second stage in which listlessness and drowsiness are the prominent symptoms, the patient finally falling into a deep sleep; the pulse is slow and full, the pupils are contracted to a pin-point size, the respirations are slow and difficult, the muscles are relaxed, and the face is pale. In this stage it is still possible to arouse the patient by loud noises, shaking, etc. From this stage, unless proper treatment is given, the patient gradually passes into the third, that of absolute coma and insensibility—a sleep from which he never awakens, death finally resulting from paralysis of the respiratory and other life-centers.

[1] Modern Materia Medica and Therapeutics.

The author well remembers his first experience in poisoning a cat with opium in the pharmacy course of instruction. A moderate dose of morphin sulphate was hypodermically administered. In a few minutes the animal imagined it had caught a mouse and was happy playing with it; after a short time, it became drowsy and fell asleep—here the pupils were contracted, respiration was slow and labored, and the muscles completely relaxed; finally, perhaps a half-hour from the time the first symptoms were manifested, the cat passed into that comatose state from which it never awoke.

In the treatment of *acute opium poisoning*, at least three objects are of prime importance: to eliminate the poison, maintain respiration, and prevent failure of the circulation. The first thing to do is to empty the stomach either by means of the stomach-pump or stimulating emetics, as zinc sulphate or mustard flour, and evacuate the bowels. Strong black coffee may be given by the mouth or bowel; it promotes wakefulness and stimulates respiration. Atropin sulphate and strychnin sulphate may also be given. The best chemic antidote is potassium permanganate; 3–5 gr. (0.2–0.3 Gm.) of this drug should be dissolved in a glassful of water and given at once, repeated in thirty minutes, if necessary. Tannic acid has also been recommended as a chemic antidote, but neither the morphin sulphate nor hydrochlorid is precipitated by it. Counterirritants, slapping, shouting in the ear, may arouse the patient from his lethargy. Continually walking the patient or anything to keep him awake is indicated. When the third stage (narcotism) is approaching, artificial respiration by Sylvester's method or by a pump is imperative.

Therapeutics.—Opium, or its alkaloids, have practically but one use in dental practice and that is to *control or relieve pain*. It is the greatest analgesic known and may well be remembered as the great "pain killer." In allaying the severe pain of *fractures*, *malignant growths*, and *acute inflammations of serous membranes* this drug has no rival. Pain of moderate intensity may often be allayed by the ordinary antipyretic and hypnotic drugs; when it is severe and excruciating and the cause cannot be at once removed, it is a waste of time to experiment with other drugs when so potent an agent as opium is obtainable. In *neuralgias* and other forms of recurrent pain opium or morphin should be used only after all other measures have failed, and then with extreme caution, on account of the danger of forming the opium habit. No drug except, perhaps, alcohol is more enticing, nor its continued use more liable to form the drug-habit than opium. It is safest for a dentist never to write a prescription for the drug. With a prescription the patient may be relieved from the

pain for which the remedy was prescribed, but subsequently he might get the prescription refilled on the least provocation, and thus the habit be innocently formed. Dover's powder is a common and valuable remedy in *acute coryza*. It is also a most efficient diaphoretic, and may be used in dentistry to *abort an acute alveolar abscess*. In conditions where the pain is not so severe, codein sulphate may be advantageously combined with other hypnotic drugs, such as acetphenetidin, amytal, etc.

Morphin has been added to various formulas for *devitalizing the pulps* of teeth. But as the drug has been shown to possess little or no local action, its use here is practically valueless, cocain, procain or neothesin being far preferable to control the irritating action of the devitalizing agent (arsenic trioxid).

Heroin was originally introduced with the claim that therapeutic doses lessen the cough reflex and slow the respiration, but that the inspirations are deepened and more powerful, so that the alveolar air is more effectively ventilated. Later investigations have shown that heroin is equally as effective as morphin in *cough*, but not more so; that it is rather less effective against *dyspnea*. The drug shares all the disadvantages of morphin and has no important advantage. It is more liable to produce habit and toxic effects, and the author knows of no condition in dental therapeutics where heroin can be used to advantage. It should be remembered that opium and its alkaloids come under the Federal Anti-Narcotic Law; and when purchased or administered a record must be kept.

Contraindications.—On account of the peculiar susceptibility of children to the drug, if avoidable, opium should not be given under five years of age. One minim (0.06 cc.) of tincture of opium (laudanum) has caused the death of a child one day old, and a few minims of camphorated tincture of opium (paregoric) have proved fatal to an infant nine months old. The death of a nursing babe is even reported where the mother had taken a medicinal dose of laudanum. The drug is, therefore, contraindicated in pregnancy and nursing mothers.

HYOSCYAMUS—U.S.P.

(Henbane.)

Hyoscyamus is the *dried leaves* and *flowering tops* of *Hyoscyamus niger*, a plant growing in Europe, Asia, and North America. The specimen should be collected from plants of the second year's growth, and should yield, when assayed, not less than 0.065 per cent. of alkaloids, of which there are two—*hyoscyamin* and *hyoscin*. Both are

official in the form of the hydrobromid, the former Hyoscyaminæ Hydrobromidum, U.S.P.; the latter Scopolaminæ Hydrobromidum; also known as hyoscin hydrobromid, obtained from various plants of the *Solanaceæ*. The average dose of the leaves of hyoscyamus is 4 gr. (0.25 Gm.). The average dose of hyoscyamin hydrobromid is $\frac{1}{200}$ gr. (0.0003 Gm.). The average dose of scopolamin hydrobromid is $\frac{1}{200}$ gr. (0.0003 Gm.). The following preparations of hyoscyamus are official:

Tinctura Hyoscyami, U.S.P. *Dose*, 10–60 min. (0.6–4.0 cc.).
Fluidextractum Hyoscyami, U.S.P. *Dose*, 5–15 min. (0.3–1.0 cc.).
Extractum Hyoscyami, U.S.P. (pilular and powdered). *Dose*, $\frac{1}{2}$–3 gr. (0.03–0.2 Gm.).

Physiologic Action.—In therapeutic doses hyoscyamus resembles belladonna in its action; it causes dilatation of the pupils, checks the salivary secretions, produces dryness of the throat, and quickens the pulse and respiration. Its narcotic action upon the brain is somewhat more profound than that of belladonna. The consensus of clinical experience seems to be, also, that hyoscyamin and atropin closely resemble each other in their action; with scopolamin (hyoscin) the action is quite different, this drug being a distinct hypnotic in that it depresses rather than stimulates the respiratory center.

Therapeutics.—Neither hyoscyamus nor its alkaloids are extensively used in dentistry; belladonna and atropin answering all of the purposes for which the former drugs could be employed. Scopolamin hydrobromid and morphin sulphate in combination have been injected hypodermically previous to the administration of general anesthetics as a means of inducing a more *tranquil anesthesia*. By this means there is said to be an absence of mental excitement, bronchial irritation, and vomiting. In *neuralgia* in individuals where a tonic is indicated or in malarial regions, the following remedy made into 12 pills or capsules, one given before meals, will prove beneficial:

Quinin Valerianate, 24 gr. (1.5 Gm.).
Extract of Hyoscyamus, 4 gr. (0.25 Gm.).
Extract of Cinchona, 8 gr. (0.5 Gm.).

CANNABIS—U.S.P.

(Cannabis Indica, U.S.P. VIII; Indian Hemp.)

Cannabis is the *dried flowering tops* of *Cannabis sativa*, or of the variety *indica*, a pistillate plant growing in the East Indies. It contains a natural resin called *cannabin*, and the specimen of the

drug should be collected while the fruits are as yet undeveloped, for they then carry the whole of their resin. The average dose is 2 gr. (0.13 gm.). The official preparations are:

Fluidextractum Cannabis, U.S.P. *Dose,* 2–5 min. (0.13–0.3 cc.).
Extractum Cannabis, U.S.P. *Dose,* ⅛–1 gr. (0.008–0.065 Gm.).

Physiologic Action.—Internally administered in therapeutic doses, cannabis acts as a mild analgesic, hypnotic, and sedative. At first there is a marked stimulation of cerebral activities, the imagination is quickened and the flow of ideas heightened. There is generally a dreamy state accompanying these symptoms, and the sensation of pain and touch are blunted, as the centers governing these are affected. The excitement is finally followed by sleep which may last for several hours. Although alarming symptoms often follow large doses of the drug, death directly attributable to it has not been reported.

Therapeutics.—Cannabis is employed for its mild analgesic action in certain forms of *neuralgia*, especially *migraine* and *headache*. It is extensively employed as a hypnotic in *melancholia*.

The extract should be given in pill or capsule, the fluid extract in alcoholic menstruum on account of the resinous constituent (cannabin) being precipitated by aqueous solutions. The drug is not employed for many of the disorders for which it was formerly used.

TABACUM (Nonofficial)

(Tobacco.)

Tobacco is the commercial *dried leaves* of *Nicotiana tabacum*, an annual plant indigenous to tropical America, but cultivated in several parts of the world, especially in Virginia and Cuba. It contains a very poisonous, volatile, oily liquid alkaloid, called *nicotin*. The quantity of the alkaloid varies greatly in the different specimens, depending largely upon the climate and soil of the various countries in which it is raised. Cuba is supposed to produce about the best specimens of tobacco.

Physiologic Action and Therapeutics.—Tobacco is a marked depressant nauseant, and produces emesis by irritation as well as by systemic action. Its continued use by smoking or chewing it to excess produces granular inflammation of the mucous membrane of the mouth and pharynx, atrophy of the retina, dyspepsia, lowered

sexual vitality, sudden faints, nervous depression, and cardiac irritability. Used by the young, it hinders the development of the brain, and interferes with metabolism in general (Osler). It is claimed to produce cancer of the lips and tongue, blunting of the moral sense, mental aberration, and even insanity. The so-called "tobacco heart," induces many forms of nervous, painful, and oppressed cardiac action, depending upon the age, quantity used, and other conditions.

Nicotin is one of the most deadly poisons known. The author remembers poisoning a cat with this agent in the pharmacy school. The animal at once became greatly excited, then there was a wild stare, a deep sigh, and sudden death within three minutes after the ingestion of the drug. The claim that nicotin enters the body from smoking tobacco is without foundation, as the liquid alkaloid is volatile and the heat breaks it up into pyridin and collodin, compounds far less poisonous. Chewing tobacco is supposed by many laymen to allay *toothache*. The claim is not justified from the physiologic action of the drug. Tobacco is not used therapeutically in dentistry.

STIMULANTS

Stimulants are agents which increase the activity of life processes or functions. When the term "stimulant" is applied to medicinal agents it is used in various senses and is generally accompanied by such adjectives as cardiac, respiratory, gastric, restorative, etc., to indicate the various organs and processes of the body stimulated by the administration or application of the drug.

CARDIAC STIMULANTS

These are agents which *increase the functional activity or the efficiency* of the heart's action. The chief cardiac stimulants are:

Nux Vomica.
Alcohol.
Ammonia.
Digitalis.
The Nitrites.
Camphor.
Caffein.

NUX VOMICA—U.S.P.

Nux vomica is the *dried ripe seeds* of *Strychnos nux vomica*, a small tree growing in the East Indies. The drug contains two important alkaloids—*strychnin* and *brucin*, the former being in excess and fully representing the action of the crude drug, which should contain, when assayed, not less than 2.5 per cent. of the alkaloids. Brucin resembles strychnin in its action, but is much less powerful. The average

dose of powdered nux vomica is 1 gr. (0.06 Gm.). The following preparations are official:

Tinctura Nucis Vomicæ, U.S.P. *Dose,* 5–20 min. (0.3–1.3 cc.).
Fluidextractum Nucis Vomicæ, U.S.P. *Dose,* 1–5 min. (0.06–0.3 cc.).
Extractum Nucis Vomicæ, U.S.P. *Dose,* ⅛–½ gr. (0.008–0.03 Gm.).

As has been stated, strychnin fully represents the action of nux vomica. This alkaloid was official in previous pharmacopeias, but was deleted in the U.S.P. X. It is now represented by its salts.

STRYCHNINA (Nonofficial)

The alkaloid occurs as colorless crystals or a white crystalline powder, odorless and having an intensely bitter taste; sparingly soluble in water. Two salts of strychnin are official, the sulphate (Strychninæ Sulphas, U.S.P.) and the nitrate (Strychninæ Nitras, U.S.P.). Both in appearance resemble the alkaloid itself, but are much more soluble in water. The average dose of strychnin or of either of its salts is 1/40 gr. (0.0015 Gm.).

Strychnin is a constituent of the following preparations:

Glycerite of the Phosphates of Iron, Quinin, and Strychnin, N.F.
Syrup of the Phosphates of Iron, Quinin, and Strychnin, N.F.
Compound Syrup of Hypophosphites, N.F.
Compound Laxative Pills, N.F.
Elixir Iron, Quinin, and Strychnin, N.F.

Physiologic Action.—Strychnin is a true cardiac stimulant, the pulse becoming stronger and more rapid under its influence as a result of its action upon the heart and vasomotor center. The drug also acts as a powerful respiratory stimulant, the movements of respiration becoming deepened and quickened. The chief action of strychnin is upon the nervous system. Here it acts as a powerful stimulant to the spinal cord, especially the centers governing the movements of the body. The most marked effect of the drug, in toxic doses, is increased reflex irritability of the spinal cord, which is shown most conspicuously by the production of muscular rigidity. Nux vomica or strychnin, in small doses, strengthens the muscular movements of the stomach and increases the flow of gastric secretions. It therefore acts as a stomachic. The drug is eliminated principally through the kidneys.

Poisoning and Treatment.—If the dose of strychnin is within therapeutic limits, yet sufficient to produce slight toxic effects, the first symptom is likely to be a feeling of uneasiness with heightened reflex irritability, and this may be followed by muscular twitching in some part of the body. With larger doses, spinal convulsions result from the slightest external irritation, causing the patient to rest on his head and feet (opisthotonos); the flexor muscles are overcome by the extensors, and the feet are curved inward. The convulsions for the most part are intermittent; during the intermission there is complete muscular relaxation. During the attack the contraction of the facial muscles causes the patient to grin in a ghastly manner, but the muscles of the jaws are unaffected until toward the last. This latter diagnostic sign should be remembered, as strychnin poisoning may become confused with tetanus on account of the rigidity of the muscles during the convulsive attacks. In tetanus the muscles of the jaw are very early implicated. Other diagnostic marks of tetanus, as contrasted with it, are slower development of the symptoms and the continuous muscular rigidity. There is never complete muscular relaxation even in the intermission of the spasms as there is in strychnin poisoning.

The number of convulsive seizures varies in different instances, but generally three or four are fatal; the patient succumbing to asphyxia and exhaustion. In the *treatment of strychnin poisoning*, if the patient is seen early enough, emetics, particularly apomorphin hydrochlorid (1/10 gr.–0.006 Gm.) hypodermically, should be given, followed by washing out the stomach. If violent convulsions already are present, evacuation of the stomach, as a rule, is contraindicated, as either emetics or the stomach-pump would provoke further attacks. Inhalations of chloroform or amyl nitrite will control the spasms. As a chemic antidote tannic acid in solution may be administered. Probably the best physiologic antidotes are potassium bromid (1–2 dr.—4.0–8.0 Gm.) and chloral hydrate (20 gr.–1.3 Gm.); when the patient is unable to swallow, the latter drug (1 dr.–4.0 Gm.) may be given in an enema (per rectum). These agents depress the nerve centers stimulated by the strychnin. Since the slightest external stimulus will provoke convulsions, the patient should be disturbed as little as possible.

Therapeutics.—Nux vomica or strychnin is used chiefly as a cardiac stimulant, a respiratory stimulant, a motorexcitant, and a stomachic. Strychnin sulphate, in soluble tablet form of proper therapeutic dose (1/40 gr.–0.0015 Gm.), should be in every dental office. Being both a cardiac and respiratory stimulant it makes a

valuable remedy in cases of *poisoning* by drugs which depress the cardiac and respiratory center. In poisoning by cocain, opium, chloral hydrate, aconite, ether, chloroform, or ethyl chlorid, it should be given hypodermically in full doses and repeated, if necessary, in fifteen minutes. In *neuralgia* due to an atonic condition, strychnin is indicated. Here it may be given in either the elixir, syrup, or glycerite of the phosphates of iron, quinin, and strychnin.

Incompatibles.—Strychnin is incompatible with tannic acid, alkalies, and the salts of the halogen elements (Cl, I, and Br.).

ALCOHOL—U.S.P.

(Alcohol; Ethanol; C_2H_5OH.)

Ethyl alcohol is obtained by the distillation of fermented saccharaceous substances. To be up to the official standard it must contain 92.3 per cent. by weight or 94.9 per cent. by volume at 15.56°C. of absolute ethyl alcohol. It will be observed that the temperature at which alcohol is measured is not the standard temperature (25°C.) of the U.S.P. X. Exception was made in the temperature for alcohol in order to correspond with the Government regulation. It occurs as a colorless, transparent, mobile, and volatile liquid, having a pungent odor, and a burning taste; miscible with water, ether, and chloroform in all proportions. It is inflammable and burns with a bluish, nonluminous flame.

The following preparations are official:

Alcohol Dehydratum, U.S.P., Alcohol Absolutum, U.S.P. VIII (99 per cent. Alcohol).
Alcohol Dilutum, U.S.P. (41 to 42 per cent. by weight or 48.4 to 49.5 per cent. by volume, at 15.56°C. of Absolute Alcohol).
Spiritus Frumenti, U.S.P. (Whisky; 37 to 47.5 per cent. Alcohol, distilled from fermented grain).
Spiritus Vini Vitis, U.S.P. (Brandy; 39 to 47 per cent. Alcohol, distilled from fermented grapes).

The following nonofficial preparations contain alcohol:

Spiritus Juniperi Compositus, U.S.P. VIII (equivalent to Gin; about 60 per cent. Alcohol).
Vinum Album, U.S.P. VIII (White Wine; 7 to 12 per cent. Alcohol).
Vinum Rubrum, U.S.P. VIII (Red Wine; 7 to 12 per cent. Alcohol).
Rectified Spirit (85 per cent. by weight of Absolute Alcohol).
Proof Spirit (49 per cent. by weight of Absolute Alcohol, Volatile Oil, and other foreign material).

Gin (42 per cent. by weight of Absolute Alcohol, distilled in Holland from rye or barley, and flavored with juniper berries or hops).

Malted Liquors (Beer, Ale, and Porter) are prepared by fermenting malted grain with hops and adding other bitters. Beer contains 2 to 3 per cent. of Alcohol; ale and porter, from 4 to 6 per cent., besides carbonic and lactic acids, malt extract, various aromatics, and certain salts of sodium and potassium.

The formerly official wines are made by fermentation of pure grape juice.

Physiologic Action.—There is much diversity of opinion regarding the physiologic action and uses of alcohol. Applied to the skin, it extracts water from the tissues and acts as a detergent and antiseptic. On the mucous membrane it extracts water with greater rapidity, coagulates albumin, and causes a whitened and corrugated surface. The gastric functions, as well as the flow of saliva, are reflexly stimulated by its local action in the mouth.

Internally administered, alcohol reflexly and rapidly stimulates the heart before absorption can take place, the effect upon the circulation persisting after the absorption of the drug. It depresses the vasoconstrictors; thus arterial tension is raised, though the arterioles are dilated. Toxic doses depress the heart's action, and still further dilate the peripheral blood-vessels. This action of alcohol, in causing the heart to beat stronger and faster, at the same time dilating the blood-vessels—especially those of the peripheries—renders the drug one of the most valuable diffusible stimulants (Butler). The dominant action of alcohol is on the nervous system. It first stimulates and then paralyzes all parts of the nervous system.

Poisoning and Treatment.—The poisonous action of alcohol may be discussed as *acute* and *chronic alcoholism*.

Acute Intoxication.—The ingestion of large quantities of alcohol produces certain characteristic symptoms: Flushing of the face, mental excitement, a quickened pulse and respiration; in a short time the speech becomes incoherent, the pupils are dilated, then follows delirium, loss of coördination, subnormal temperature, vomiting, loss of ability to control the acts of toilet, and, finally, stupor and coma. If the dose has not been too large, recovery follows in a day or two.

Stevens[1] emphasizes the care to be taken in order to distinguish acute alcoholism from uremia, opium poisoning, and apoplexy. The urinous odor of the breath, the small pupils, and the presence of

[1] Modern Materia Medica and Therapeutics.

albumin in the urine will serve to distinguish *uremia*. The small pupils, slow and labored respiration, and slow and full pulse will point to *opium poisoning*. The unequal pupils, hemiplegia, and high temperature will indicate *apoplexy*. In the *treatment of acute alcoholism* the stomach should be emptied of all unabsorbed alcohol by the stomach-pump, and a stimulating emetic (mustard flour), or the hypodermic injection of apomorphin ($\frac{1}{10}$ gr.–0.006 Gm.) is indicated. Cautious inhalations of ammonia should be given, together with the internal administration of black coffee. The patient should be made to perspire freely by the application of external heat (warm blankets, etc.), and if there is danger of collapse, strychnin sulphate ($\frac{1}{30}$ gr.–0.002 Gm.) should be hypodermically administered and artificial respiration practised.

Chronic alcoholism is generally the result of the continuous and excessive use of alcohol, and is characterized by disturbed sleep, fine tremor, mental impairment, gastric irritation, injection of the eyes, and redness of the nose and cheeks from permanent dilatation of the capillaries. A frequent complication of chronic alcoholism is *delirium tremens*. This condition is manifested by great mental excitement, insomnia, incoherent speech, tremors, and terrifying hallucinations of sight and hearing. In favorable cases recovery follows in a few days, but frequently symptoms of typhoid and pneumonia develop, and the attack ends in death. In the *treatment of delirium tremens* the main indications, according to Butler,[1] are:

1. *Elimination* by diaphoresis, catharsis, diuresis, warm baths, etc.

2. *Support.*—Some alcohol may be necessary. Easily digested food. Enemata, if necessary.

3. *Quiet.*—Hypnotics: opium, chloral hydrate, the bromids.

In the *treatment of chronic alcoholism* it is necessary to consider the character of the individual affected. Butler states that a thoughtful and extended experience with dipsomaniacs will convince most observers that the vast majority of them suffer from a disease possessing usually a distinct and traceable etiology, and resulting from either an inherited or acquired neurosis. It is a condition akin to epilepsy; the treatment, therefore, turns on the discovery of the conditions preliminary to the drinking period and the determination whether this can be prevented by dietetic and therapeutic measures, as is done in cases of epilepsy.

The medicinal agents employed are strychnin, atropin, small doses of such alteratives as arsenic, potassium iodid, and mercury, while phosphorus and other restoratives and tonics will prove efficacious.

[1] Text-Book of Materia Medica, Therapeutics and Pharmacology.

Therapeutics.—Alcohol is extensively used locally in dentistry as a dehydrater, detergent, and antiseptic. Its action upon bacteria is no doubt due to its power of abstracting water and of coagulating albumin. According to the experiments of pharmacologists, the most effective dilutions of alcohol against the strongly resisting (nonsporing) bacteria, such as the pus organisms, are those containing from 60 to 70 per cent. by volume. The author suggests 70 per cent. alcohol to which 1 gr. (0.064 Gm.) of thymol to the fl. oz. (30.0 cc.) is added. This is called *modified alcohol*, and is useful for sterilizing the teeth included in the rubber dam for *aseptic root-canal work*, and other aseptic operations involving the mucous membrane.

For spraying the mouth previous to performing any dental operation, the author is very partial to cinnamon water to which from 2–5 per cent. of alcohol has been added. It should be remembered that alcohol is less valuable as a disinfectant than as an antiseptic and as a vehicle for stronger agents of this class; therefore, from 10 to 25 per cent. alcohol makes an excellent addition to aqueous antiseptic solutions. Absolute alcohol is frequently added to tooth-pastes for its antiseptic and solvent power. The drug is used as a styptic to check *capillary oozing*, and a very efficient means of reducing *temperature in fever* is to bathe the skin with alcohol; the method is also employed to check *excessive sweating*. Alcohol is a positive antidote for phenol, and whenever the latter agent is being used about the mouth, it should be in a convenient place to neutralize the caustic action of phenol, should the latter accidentally get on the soft tissues of the mouth. Alcohol is employed internally as a diffusible circulatory stimulant, a stomachic, a food, and an antidote for phenol. In all forms of sudden heart-failure, as in *syncope*, *shock*, *snake-bite*, etc., it is an invaluable stimulant. Whisky or brandy should be in every dental office to be used as a cardiac stimulant in cases of *cocain poisoning* or other conditions which depress the heart. In this connection it is to be regretted that dentists are unable to obtain these drugs on their own account because of the present ruling of the Federal Department governing the enforcement of the Volstead Act.

ACETONUM—U.S.P.

(Acetone; Dimethyl-ketone; $CH_3.CO.CH_3$.)

Acetone is a transparent, colorless, mobile and volatile liquid, having a characteristic odor, a sweetish, pungent taste, and containing not less than 99 per cent. of $CH_3.CO.CH_3$. It is miscible without cloudiness with water, alcohol, ether, chloroform, and

most volatile oils. The product is inflammable and should be kept in well-closed containers, in a cool place, remote from fire, such as an electric spark or gas flame.

Physiologic Action and Therapeutics.—Acetone resembles ethyl alcohol in its action and is used by many dentists as a substitute for alcohol in *desiccating root-canals of teeth* and in other places.

AMMONIA

(NH_3.)

Ammonia is obtained as a by-product in the manufacture of coal-gas. It occurs as a colorless gas, having a very penetrating odor and an acrid taste. It is chemically soluble in water, and in chemistry it is considered a hypothetical metal, as it acts like a base in uniting with acids to form salts. The following preparations are official:

Aqua Ammoniæ Fortior, U.S.P. (Stronger Ammonia Water; 28 per cent. by weight of the Gas).
Aqua Ammoniæ, U.S.P. (Ammonia Water; 10 per cent. by weight of the Gas).
Spiritus Ammoniæ Aromaticus, U.S.P. (Aromatic Spirit of Ammonia; contains Ammonium Carbonate, 34; Ammonia Water, 90; Oil of Myristica, 1; Oil of Lemon, 10; Oil of Lavender Flowers, 1; Alcohol, 700; Water to make 1,000). *Dose*, ¼ to 1 fl. dr. (1.0–4.0 cc.).
Linimentum Ammoniæ, U.S.P. IX. Externally.

Physiologic Action.—Ammonia has a decidedly irritant local action, and in concentrated solution it speedily produces vesication. The drug has the decided advantage of being a gas which permits of inhalation, and its irritant action upon the mucous membrane of the respiratory passages reflexly stimulates the cardiac and respiratory centers; both the strength and rapidity of the pulse and the depth and rapidity of the respirations are markedly increased. Given in weak solutions, the drug stimulates the flow of gastric juice, its action here resembling that of other alkalies. The gas acts upon the nervous system by stimulating the motor centers of the spinal cord, and thus reflex activity is increased.

Poisoning and Treatment.—In toxic doses preparations of ammonia are powerful corrosive poisons. The characteristic symptoms are severe burning pain in the fauces, esophagus, and stomach, with intense gastroenteritis. The violent irritation of the throat sometimes causes edema of the larynx, resulting in almost immediate death from asphyxia. In the *treatment of ammonia poisoning* the drug

should be neutralized by some weak acid, like vinegar. This should be followed by demulcent drinks, opium being indicated for the relief of pain.

Therapeutics.—The chief use of ammonia in dental therapeutics is as a cardiac and respiratory stimulant. The drug acts quickly, and is an invaluable remedy in *syncope*, *collapse*, and other forms of *sudden heart failure*. When it is desired to give the drug by inhalation, as can easily be done on account of the volatility of the gas from its solutions, it is best to select ammonia water as the preparation to use. For internal administration the aromatic spirit of ammonia should be selected and given well diluted. Ammonia water in a specially prepared ampule, called "aspirol," and aromatic spirit of ammonia in 30 min. (2.0 cc.) ampules are now on the market. These are convenient forms in which to keep the drug and should be in every dental office.

The liniment of ammonia, formerly official, is a popular counter-irritant remedy in *chronic rheumatism*, *joint affections*, and *chilblains*.

Incompatibles.—Ammonia is incompatible with all acids, chloral hydrate, and alkaloids. With ferric salts it forms ferric hydroxid, which is an antidote for arsenic. With formaldehyd it forms urotropin.

AMMONII CARBONAS—U.S.P.

(Ammonium Carbonate; $NH_4HCO_3.NH_4NH_2CO_2$.)

The official **ammonium carbonate** is really a mixture of ammonium acid carbonate and ammonium carbamate. It occurs in white, internally translucent, crystalline masses, having an extremely pungent odor, and an acrid taste; soluble in 4 parts of water. The average dose is 5 gr. (0.3 Gm.).

Physiologic Action and Therapeutics.—This drug is a cardiac and respiratory stimulant, due to the ammonia gas which is constantly liberated. It is also a stimulating expectorant. It enters into the composition of aromatic spirit of ammonia, which preparation is extensively used in dental therapeutics.

CAFFEINA—U.S.P.

(Caffein; $C_8H_{10}N_4O_2.H_2O$.)

Caffein is an alkaloid obtained from the *leaves* of *Thea sinensis* (tea), or from the *seeds* of *Coffea arabica* (coffee). It occurs in fine, colorless, silky crystals, without odor, and having a bitter taste;

soluble in about 46 parts of cold water. The average dose is 2½ gr. (0.15 Gm.). The following preparations are official:

Caffeina Citrata, U.S.P. (Caffein Citrate). *Dose*, 2–5 gr. (0.13–0.3 Gm.).
Caffeinæ Sodio-Benzoas, U.S.P. *Dose*, by mouth, 5 gr. (0.3 Gm.), hypodermic, 3 gr. (0.2 Gm.).

Physiologic Action.—Caffein is a powerful cardiac and respiratory stimulant. Its action upon the circulatory system results in high blood-pressure and increased frequency of the pulse, due in part to its direct influence upon the heart and its stimulating action upon the vasomotor centers. The brain seems to be especially susceptible to the influence of caffein, small doses sharpen the intellect and produce profundity of thought, and wakefulness. The drug also acts as a diuretic, stimulating the secreting structure of the kidneys, and is quickly eliminated through these organs.

Therapeutics.—Caffein is an entirely safe drug to be used in large dose, hence it is one of the best stimulants to employ in *poisoning* by narcotic drugs, like cocain, opium, etc. Caffein citrate is the preparation generally used because it is more soluble than caffein. Strong black coffee is also used.

The drug is a constituent of compound acetanilid powder, N.F. Its action overcomes the depressant effect of acetanilid upon the heart. It may also be combined with acetphenetidin or a bromid and used with excellent results in *migraine* and *nervous headache*.

THEOBROMINA (Nonofficial)

(Theobromin; $C_7H_8N_4O_2$.)

Theobromin is an alkaloid closely related to caffein and derived from the *seeds* of *Theobroma cacao*, a tree indigenous in Brazil and Central America. It is also grown extensively in other parts of South America and the West Indies, and is known as the chocolate tree. Students frequently confuse the names cacao and coca—the latter containing cocain, an alkaloid used for local anesthetic purposes (see page 144). The dose of theobromin is from 5–10 gr. (0.3–0.65 Gm.).

Physiologic Action and Therapeutics.—The action of theobromin closely resembles caffein, though its effect on the central nervous system is much less, and by some authorities it is claimed to have no stimulating effect whatever. The drug is a diuretic, producing diuresis chiefly through its influence on the renal epithelium. It is eliminated in the urine partly unchanged and partly as xanthin

bodies. Owing to its greater solubility the official *sodio-theobromin salicylate* (Theobrominal Sodio-Salicylas, U.S.P.) a combination containing not less than 46.5 per cent. of theobromin and not less than 35 per cent. of salicylic acid, is preferable for use to the pure alkaloid. *Diuretin* is a trade name for a proprietary preparation composed of sodio-theobromin salicylate. The dose is from 10–20 gr. (0.65–1.3 Gm.), given in capsules or in solution.

Coco-vitamin is a trade name for a preparation containing cod liver oil, 40 per cent.; B-vitamin extracts, 40 per cent.; malt extract, 10 per cent.; potassium hypophosphite 1.7 per cent.; with chocolate and aromatics. It is used to supplement faulty or deficient diets in the under nourished and convalescent, and to promote normal bone growth and dentition. It is directed to be kept in a cool place, comes in an amber colored bottle bearing a shake label. Coca-vitamin has a pleasant taste and may be taken alone, with a little milk, or mixed with water. The dose for infants is ¼ to ½ teaspoonful with each feeding. Children, 1 to 3 teaspoonfuls three times a day. Adults, 1 to 2 tablespoonfuls three times a day. Remedies like this which are given more as a food than a medicine should be taken at the end of gastric digestion, as far as possible, about 1½ to 2 hours after a meal, and when pancreatic secretion is well started. They should never be given before meals, for this would lessen or completely take away the appetite and thus defeat the object sought—to nourish or build up the tissues of the body. It is well to remember here that a *vitamin unit* is the average daily amount of vitamin necessary to produce normal growth in the test animal when all other ingredients of the diet are adequate.

DIGITALIS—U.S.P.

(Foxglove.)

Digitalis is the *dried leaves* of *Digitalis purpurea*, a biennial plant growing in Central and Southern Europe. It contains several principles, all of which are glucosidal in character, the most important being *digitalin*, *digitoxin*, *digitalein*, *digitonin*, and *digitin*. The first two represent more or less imperfectly the action of digitalis upon the heart, and since both are freely soluble in alcohol and practically insoluble in water, it will at once be observed that the most active principles of the drug are contained in the tincture, and the least active in the infusion; both of which preparations of digitalis are official:

Tinctura Digitalis, U.S.P. *Dose*, 5–20 min. (0.3–1.3 cc.).
Infusum Digitalis, U.S.P. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Physiologic Action.—Digitalis is a powerful cardiac stimulant. It does not increase the rapidity of the heart's action; it rather slows the pulsations and raises the blood-pressure, but in spite of this the efficiency of the contraction is increased and the pulse improved in character. In therapeutic doses the drug has practically no effect except on the circulation. The slowing of the pulse results from a prolongation of the diastole, and this in turn is due to stimulation of the vagi. The increased blood-pressure is due to the twofold action of the drug, that of securing efficiency by the direct action upon the heart, and to the contraction of the arterioles, which results indirectly from the stimulation of the vasomotor center, and directly from the action on the vessel-walls. In cases of low arterial pressure, when the urine is scanty, digitalis acts as a diuretic.

A disadvantage of digitalis medication is the varying strength of the crude drug. Pharmaceutic chemists have attempted to remove this disadvantage by *standardizing* their preparations. The following methods of standardization are most extensively used:

1. The frog-lethal dose method.
2. The frog-systolic standstill method, of which there are several modifications.
3. The guinea-pig lethal dose method.
4. The intravenous cat method.

Poisoning and Treatment.—Digitalis is more rapidly absorbed than eliminated; because of this, *cumulative action* may follow the prolonged use of the drug even in therapeutic doses. Toxic symptoms may result from this source or from the ingestion of a single poisonous dose. Poisoning is characterized by gastrointestinal disturbances, abdominal pains, vomiting, and purging, with slow pulse, feeble respiration, dilated pupils, headache, delirium, and stupor. If a fatality results, it is generally from ten to forty-eight hours after the ingestion of the drug, as digitalis is a slow poison. In the *treatment of poisoning*, the stomach-pump should be employed. Tannic acid is a chemic antidote and may be given. Body temperature should be maintained by external heat, especially applied to the abdomen. Alcoholic stimulants are often indicated. The patient should be kept in the recumbent position, not being allowed even to raise his hand or head from the bed.

Therapeutics.—The chief use of the drug in dental therapeutics is as a cardiac stimulant. Hypodermic injections of the tincture of digitalis or of digitalin may be employed to increase the efficiency of the heart's action in *syncope*, *collapse*, and *poisoning* by cardiac depressants. It is best here to use the drug in conjunction with stimu-

lants which act more quickly (alcoholic stimulants). The drug is contraindicated in cases of *aneurysm*.

AMYLIS NITRIS—U.S.P.

(Amyl Nitrite; $C_5H_{11}NO_2$.)

Amyl nitrite is prepared by the action of nitric acid upon amylic alcohol; the product, being a highly volatile liquid, is obtained by distillation. It has a strong ethereal odor.

Physiologic Action.—Following the inhalation of amyl nitrite there is a marked flushing of the face, due chiefly to the dilatation of the capillaries. The heart's action is increased, and the pulse is soft and compressible. There is a marked fall in blood-pressure because of the dilatation of the arterioles, which results from the paralyzant action of the drug upon the muscle fibers found in these structures. The nitrites cannot be regarded as powerful cardiac stimulants, but their action is equivalent to such, for by dilating the arterioles they largely remove the resistance against which the heart has to force the blood, thus making the work of this organ much easier to perform. These drugs, therefore, should be regarded as vasodilators, and not as true cardiac stimulants; but, on account of their action as vasodilators, they may be considered circulatory stimulants. The drug is largely eliminated through the kidneys.

Poisoning and Treatment.—In toxic doses amyl nitrite produces an exceedingly rapid and weak heart, cyanosis, slow and shallow respiration, vertigo, headache, and disordered vision, death resulting from cardiac and respiratory failure. In the *treatment of poisoning* the heart's action must be sustained. Strychnin and digitalis will be found useful. Atropin may be administered, together with cold applications to the head, alcoholic stimulants, and, if necessary, artificial respiration. Adrenalin is claimed to be useful as it contracts the dilated arterioles.

Therapeutics.—Long[1] states that it is to be regretted that the nitrites have been considered direct heart stimulants; because of this they are extensively used in cases where the blood-pressure is already too low to permit efficiency of circulation, as in chloroform and other drug poisonings. Amyl nitrite is useful to relax *spasms* and to lower arterial tension. On account of the rapidity with which the drug is absorbed it is never necessary to give nitrites hypodermically. The effect of amyl nitrite may be obtained almost instantly by inhalation, and a dose of spirit of nitroglycerin (1–3 min.—0.06–0.2 cc.) placed

[1] Dental Materia Medica, Therapeutics and Prescription Writing.

under the tongue will produce its full effect in less than five minutes. Amyl nitrite may be obtained in glass capsules or pearls, containing the requisite dose (2–5 min.—0.13–0.3 cc.), which are easily crushed in a handkerchief, and should always be given by inhalation. In this manner it may be employed with benefit to relieve the *convulsions* of *epilepsy*, *tetanus*, *uremia*, and *strychnin* poisoning. The drug is used in *syncope* and *collapse* from other causes, but the diffusible stimulants are far preferable.

GLYCERYLIS NITRAS (Nonofficial)

(Nitroglycerin; Glonoin; Glyceryl Trinitrate; $C_3H_5(NO_3)_3$.)

Nitroglycerin is obtained by nitric acid or a mixture of nitric and sulphuric acid on dehydrated glycerin. It occurs as a clear, colorless liquid, with an odor and taste resembling that of alcohol. It explodes with great force, and should be kept in a cool place, away from lights and fire. It is official in the following form:

> Spiritus Glycerylis Nitratis, U.S.P. (Spirit of Nitroglycerin; an alcoholic solution containing 1 per cent. by weight of Glyceryl Trinitrate). *Dose*, 1–3 min. (0.06–0.2 cc.)

Physiologic Action and Therapeutics.—Nitroglycerin is preferable to amyl nitrite, whose action it resembles, for internal administration. It is used in dentistry as a cardiac stimulant, and for this purpose it may be found as a constituent of local anesthetic solutions. It, however, is far inferior to strychnin or atropin as an agent to overcome the depressant effect of cocain upon the heart.

Nitroglycerin is a valuable drug in those cases where it is desirable to relieve blood-pressure. For example, when it is deemed necessary to apply arsenic trioxid to a pulp which is in an inflammatory state, the engorged capillaries may be relieved and the pain mitigated by the administration of this drug (see page 377).

RESPIRATORY STIMULANTS

These are agents which *increase the functional activity of the respiratory centers or the efficiency* of the respiratory apparatus. The chief respiratory stimulants are:

Belladonna (Atropin).	Strychnin.*
Ammonia.*	Caffein.*

All of these drugs have been elsewhere discussed except the first-mentioned.

BELLADONNA

(Deadly Nightshade.)

Belladonna is a herbaceous perennial plant growing in the woods, chiefly in the mountainous districts of Central and Southern Europe. Both the *dried leaves* (*Belladonna Folia, U.S.P.*) and the *dried root* (*Belladonna Radix, U.S.P.*) of *Atropa Belladonna* are official. The drug contains an important alkaloid, *atropin*, to which its physiologic activity is due. The average dose of the powdered leaves and root is 1 gr. (0.06 Gm.). The following preparations are official:

Tinctura Belladonnæ Foliorium, U.S.P. *Dose*, 5–20 min. (0.3–1.3 cc.).
Extractum Belladonnæ Foliorium, U.S.P. (pilular and powdered). *Dose*, 1/8–1/4 gr. (0.008–0.016 Gm.).
Emplastrum Belladonnæ, U.S.P.
Unguentum Belladonnæ, U.S.P. (10 per cent. from Extract).
Fluidextractum Belladonnæ Radicis, U.S.P. *Dose*, 1–3 min. (0.06–0.2 cc.).

The action of belladonna is due entirely to atropin which it contains. This alkaloid is official.

ATROPINA—U.S.P.

Atropin occurs in the form of white, acicular crystals, or a crystalline powder, odorless, having a bitter, acrid taste; soluble in 455 parts of water, 2 parts of alcohol, 25 parts of ether, 1 part of chloroform, and about 27 parts of glycerin, at 25°C. One salt of atropin is official (Atropinæ Sulphas, U.S.P.), and in appearance resembles the alkaloid itself, except that it is more freely soluble in water. The average dose of atropin or of its salt is 1/120 gr. (0.0005 Gm.).

Physiologic Action.—The action of belladonna is dependent upon the amount of contained atropin. Applied locally in combination with absorbable substances—alcohol, camphor, animal fat, glycerin, etc.—atropin acts as a depressant to all highly organized tissues, exerting an analgesic and antisecretory influence. Medicinal doses of atropin, taken internally, produce dryness of the throat, dilatation of the pupils, quickening of the pulse, deepening of the respirations, and occasionally talkative delirium and erythematous rash. It is well to remember here that medicinal doses stimulate the respiratory center, while toxic doses paralyze it.

The salivary secretion is lessened through paralysis of the peripheral endings of the secretory fibers only of the chorda tympani nerve in the submaxillary gland (Butler). The drug also diminishes all of

the secretions of the body, and its elimination is effected chiefly through the kidneys.

Poisoning and Treatment.—The characteristic symptoms of *atropin poisoning* are dryness of the throat, dilated pupils, rapid pulse, quick respiration, uneasiness, talkative delirium, erythematous rash, with, ultimately, stupor, collapse, and death from paralysis of the respiratory center. In the *treatment of poisoning* the stomach should be evacuated and then washed out with solutions of tannic acid—the chemic antidote. Cardiac and other respiratory stimulants (caffein) should be cautiously administered as the symptoms indicate.

Therapeutics.—Atropin is one of the best remedies at our command for controlling the secretions of the body. In cases where it is necessary to keep the *field of operation* dry, as in *treating and filling* teeth where the rubber dam cannot be successfully adjusted, atropin may be administered a few hours previous to operating with excellent results. In *salivation* from mercury the drug is likewise useful. In *hyperidrosis* of the hands and feet preparations of belladonna are used both externally and internally. Combined with camphor and other drugs, extract of belladonna is a useful remedy in *acute coryza*. Probably the greatest use atropin has in dental therapeutics is in the treatment of *shock* and *collapse* from local and general anesthetics, and also in the treatment of *poisoning from narcotic drugs*. In these cases atropin sulphate, hypodermically administered, stands next to strychnin and its salts.

Liniment of belladonna, formerly official, is a valuable remedy in the treatment of *neuralgia*.

GASTRIC STIMULANTS

Gastric stimulants, called also *stomachics*, are agents which sharpen the appetite and promote the functional activity of the stomach. The gastric stimulants are called "bitter tonics," and they include the following:

Gentian. Cinchona.*
Wild Cherry. Hydrastis.*
Nux Vomica.*

GENTIANA—U.S.P.

(Gentian.)

Gentian is the *dried rhizome* and *roots* of *Gentiana lutea*, a small perennial plant indigenous to the mountainous districts of Central Europe. It contains a bitter glucosid, *gentiopicrin*, to which its

stomachic property is due. The average dose is 15 gr. (1.0 Gm.). The official preparation is:

Tinctura Gentianæ Composita, U.S.P. (10 per cent. with Orange Peel and Cardamom Seed). *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Infusum Gentianæ Compositum (Nonofficial). *Dose*, ½ to 1 fl. oz. (15.0–30.0 cc.).

Physiologic Action and Therapeutics.—The action of gentian is due to the bitter glucosid which it contains, and like all bitter tonics its effect is immediate, due to the local action of the drug. It augments the secretions from the salivary and gastric glands, and thus aids digestion and improves nutrition. There is an intimate relationship between the stomach and the senses of taste and smell, and anything bitter in the mouth reflexly stimulates the gastric secretion.

Gentian is not much employed in dental practice. It may be considered one of the most reliable bitter tonics. In *periodontoclasia* associated with *neuralgia* due to a general atonic condition, the compound tincture of gentian may be advantageously combined with tincture of valerian (equal parts of the two) and given before meals in teaspoonful doses. Where the pyorrhea has caused indigestion an antacid, like sodium bicarbonate, may be combined with some preparation of gentian; because of the insolubility of sodium bicarbonate in alcohol, the compound infusion of gentian should be selected. A useful combination is: Sodium bicarbonate, ½ dr. (2.0 Gm.); compound infusion of gentian, 3 fl. oz. (90.0 cc.). This may be given in tablespoonful doses, before meals.

PRUNUS VIRGINIANA—U.S.P.

(Wild Cherry.)

Prunus virginiana is the *bark* of *Prunus serotina*, a large tree indigenous to North America. It contains tannic acid, a bitter principle, a ferment, *emulsin*, and a glucosid, *amygdalin*. In the presence of the ferment and water the glucosid is broken up into *hydrocyanic acid* and a *volatile oil*. The average dose of wild cherry bark is 30 gr. (2.0 Gm.). The following preparation is official:

Syrupus Pruni Virginianæ, U.S.P. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Physiologic Action and Therapeutics.—Wild cherry is a bitter tonic. It might also be considered a sedative tonic. While it is peculiarly bitter, it is not unpleasant, and is well tolerated by the stomach. The syrup of wild cherry is a common ingredient in

"cough-mixtures," and is supposed to quiet the cough and allay the irritability of the nervous system in *bronchial affections*. This effect is doubtless due to the hydrocyanic acid which it contains. The syrup has an agreeable taste and serves as an excellent vehicle for unpalatable drugs.

The other stomachics have been discussed under other headings.

RESTORATIVE STIMULANTS

These are agents which maintain or restore the bodily functions. The principal restorative stimulant is:

LIQUOR SODII CHLORIDI PHYSIOLOGICUS, U.S.P.

(Physiologic Salt Solution; Normal Salt Solution.)

This is a solution of 8.5 parts of sodium chlorid in 1,000 parts of sterile water, and closely corresponds in salinity to blood-serum. Physiologic salt solution and normal salt solution have been used in the past interchangeably. Strictly speaking, normal salt solution is a 5.84 per cent. solution of sodium chlorid and is used in chemic processes, while physiologic salt solution is the one used in medical and and dental practice, and this is the better term to use in therapeutics. Some writers give the strength of physiologic salt solution as 0.6 per cent. of sodium chlorid. The U.S.P. gives 0.85 per cent. These facts are mentioned because of the misunderstanding which has seemingly arisen. Physiologic salt solution is regarded as a valuable stimulant in cases of *shock* or *collapse*, especially from loss of blood by *hemorrhage*. It is injected intravenously by permitting the solution, quite hot, to run slowly through a large-sized, long hypodermic needle from a fountain syringe into the lumbar region or underneath the breast. From 2 fl. oz. (60.0 cc.) to 10 fl. oz. or even 1 qt. (300.0–1,000 cc.) may be used at frequent intervals. Sollmann[1] states that the action is only short, and the injection must therefore be repeated. The restoration is brought about by the substitution of this fluid for the blood-serum. The solution is an excellent bland remedy to be used in establishing sinuses associated with alveolar abscesses, and also as a vehicle for local anesthetics and other agents (adrenalin, etc.). For making local anesthetic solutions, Ringer tablets are frequently added to sterile distilled water to make an *isotonic* solution. The Ringer tablet "B," which is generally employed, contains sodium chlorid $\frac{1}{5}$ gr. (0.05 Gm.), calcium chlorid $\frac{1}{15}$ gr. (0.004 Gm.), and potassium chlorid $\frac{1}{30}$ gr. (0.002 Gm.). One Ringer tablet "B" dissolved in $2\frac{1}{2}$ fl. dr. (10.0 cc.) of water makes a

[1] A Text-Book of Pharmacology.

0.56 per cent. solution of the salts, which with the addition of the anesthetic agent approximates closely the specific gravity of the blood-serum, making the solution *isotonic*.

According to E. V. McCullom[1] and others physiologic salt solution has long been used for *constipation* to stimulate bowel movement. On first arising in the morning the individual should drink a liberal quantity of water containing the proper amount of sodium chlorid (common salt). The solution is not quickly absorbed and excreted by the kidneys since it is isotonic to the fluids of the body i.e. contains the same amount of salt as does the blood. Under these conditions the salt water merely runs through the stomach and intestines and washes them out. McCollum states that in the morning the stomach and upper intestine are empty except for saliva and small residues of secretions. Everything which is of value has been secured from the food taken during the previous day. Further absorption now does more harm than good and the sooner the bowels are evacuated upon arising in the morning, the better for the general health of the individual. It is here where the physiologic salt solution is of value in cases of constipation. Two level teaspoonfuls of common salt added to a quart of water makes approximately a physiologic salt solution, viz. 0.85 of one per cent. The water should taste slightly salty, but not bitter. The amount required varies with the individual. The water should be neither warm nor cold (body temperature), and one should drink as much as possible with comfort about an hour or more before breakfast. With some persons, two cups will be sufficient, others three cups, and still others the entire quart. The solution will pass through more quickly if the individual lies down for a half hour or so. Breakfast should not be eaten until the salt water is out of the stomach. If taken at the proper temperature this will be accomplished in from 20 to 45 minutes. By following this practice the intestine is thoroughly washed out at the beginning of the day and gratifying results will follow. In healthy subjects there is practically no absorption of the salt water by the system. This is shown by the lack of desire to urinate, which differs from drinking a liberal amount of plain water upon arising in the morning.

MISCELLANEOUS GROUP

There are several drugs which have a peculiar action upon the nervous system other than those thus far discussed under the various headings of general remedies. Some of these drugs stimulate, while

[1] "Food, Nutrition and Health"—McCollum and Simmons.

others depress the nervous system. They will be considered here under this heading. Those of importance to dentists are:

Gelsemium. Valerian.

GELSEMIUM (Nonofficial)
(Yellow Jasmine.)

Gelsemium is the *dried rhizome* and *roots* of *Gelsemium sempervirens*, a climbing plant growing in the moist woods of southern United States. It contains two alkaloids—*gelsemin* and *gelseminin*—the former stimulates, while the latter depresses the nervous system. The general effect of the drug is the result of a blending of the actions of the two alkaloids, although in man gelseminin appears to be more potent. The average dose of powdered gelsemium is ½ gr. (0.03 Gm.). The drug itself and the following preparations were formerly official:

Tinctura Gelsemii, U.S.P. IX. *Dose*, 10 to 30 min. (0.6–2.0 cc.).

Fluidextractum Gelsemii, U.S.P. IX. *Dose*, 2–10 min. (0.13–0.6 cc.).

Extractum Gelsemii, U.S.P. IX. *Dose*, ⅙ gr. (0.01 Gm.).

Physiologic Action and Therapeutics.—Gelsemium has a distinct action upon sensory nerves and is useful, therefore, in painful affections. In large doses it depresses the spinal cord, especially its motor neurons. The drug is used in *facial neuralgia*, and appears to be most serviceable when the neuralgia arises from diseased conditions of the teeth. The fluid extract is the preparation generally employed, although Marshall[1] prefers gelseminin sulphate, giving 1/30 gr. (0.002 Gm.) every two hours until the constitutional effects are produced. This salt naturally would be more effective in neuralgic conditions than gelsemium preparations, as it is the alkaloid that depresses the nervous system; the other alkaloid (gelsemin) stimulates.

Poisoning and Treatment.—The toxic symptoms of gelsemium are drooping eyelids, disordered vision, frontal headache, falling of the jaw, muscular weakness, slow respiration, and, finally, collapse. In the *treatment of poisoning* the stomach should be evacuated, tannic acid administered as the chemic antidote, and collapse combatted with such stimulants as strychnin, whisky, and ammonia.

VALERIANA—U.S.P.
(Valerian.)

Valerian is the *dried rhizome* and *roots* of *Valeriana officinalis*, a herbaceous, perennial plant, native of Europe. It contains *valerianic*

[1] Injuries and Surgical Diseases of the Face, Mouth and Jaws.

acid and a *volatile oil*. The average dose is 30 gr. (2.0 Gm.). The following preparations are official:

Tinctura Valerianæ, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Tinctura Valerianæ Ammoniata, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).

Physiologic Action and Therapeutics.—The principal action of valerian is upon the nervous system, and it may be classed as a *nervine* in that it produces, in moderate dose, a sedative effect upon the brain and spinal cord. In *periodontoclasia* associated with more or less *neuralgia* due to a general atonic condition it may be combined with gentian with excellent results.

ALTERATIVES AND RESTORATIVES

Alteratives are agents which promote metabolic processes and thus counteract morbid conditions. They are closely related to **restoratives** in that both classes promote the processes of nutrition and aid metabolism. The latter class includes *foods*, *hematics*, and *tonics*.

Foods are substances which, when introduced into the body, supply material with which some structure is rebuilt or some vital process is maintained. They differ from medicines in that the latter modify vital processes, but furnish no material to renew the structures of the body.

Hematics or hematinics are agents which increase the hematin in the blood and restore or maintain bodily functions by enriching the red blood-corpuscles. The compounds of iron are the chief hematics.

Tonics are agents which improve the tone and impart strength and energy to the tissues. The main tonics are:

Iron and Compounds.	Hypophosphites.
Phosphorus.	Cod-liver Oil.
Calcium Phosphate.	Nux Vomica.*

Cinchona.*

The principal alteratives are:

Potassium Iodid.	Sarsaparilla.
Mercury.	Echafolta.
Arsenic.*	Calx Sulphurata.

Gold and Sodium Chlorid.

FERRUM—U.S.P.

(Iron; Fe.)

Metallic iron is official in the form of fine, bright wire.

Physiologic Action and Therapeutics.—Iron is an essential element of the body and may be regarded as a food as well as a medicine.

It enters as an essential constituent (0.4 per cent.) into a peculiar proteid body—the hemoglobin of the blood. It is through the iron compounds of the body that the greater portion of the oxidizing functions of the various cells are carried on. In a healthy state of the body, when the processes of mastication, digestion, assimilation, and nutrition are normal, there is a sufficient amount of iron furnished by the mixed diet to answer all physiologic requirements; but in many pathologic conditions there is a deficiency of iron, and the element must be furnished in the form of selected food or medicine. This is also true of calcium. There is a difference of opinion as to whether metallic iron can be assimilated by the body; some authorities claiming that it is necessary first to have the iron organized by plant life into compounds containing it, while others claim that this is not necessarily essential to the assimilation of the metal. Bunge supposed that only "organic iron" could be absorbed and assimilated by the body, the reputed action of inorganic iron being altogether indirect and due to its local effect on the alimentary canal. This theory was modified by Abderhalden to the effect that inorganic iron, while it could not be converted into hemoglobin, nevertheless stimulated the conversion of "organic iron." Later work, however (Tartakowski), seems to prove conclusively that inorganic iron is assimilated and converted into hemoglobin and in so far is therapeutically fully equal to natural complex iron compounds. Many authors and practitioners, nevertheless, still adhere to the theories of Bunge and Abderhalden. There can be no question regarding the local and astringent action of most inorganic preparations, which is absent in most of the complex iron compounds. These local actions may be desirable in some cases and undesirable in others. This aids in determining the selection of the particular iron preparation most suitable for each individual patient. Metallic iron is not used as a therapeutic agent in dentistry. In medicine it is extensively employed in diseases which affect the circulation, as *anemia* and *chlorosis*. Many iron compounds are used in dentistry and will here be considered.

Iron Compounds.—Iron forms two series of compounds—*ferrous* and *ferric*. The former are white when freshly precipitated in the absence of oxygen, but when moist and exposed to air they readily absorb oxygen and gradually change into ferric compounds, which are usually reddish-brown in color. In this change there is an array of four distinct colors—white, green, black, and brown, respectively—and in the blending of these colors there may be produced every variety of shades seen in discolored teeth. As it is quite generally

conceded that iron is the most important element to be considered in the many factors entering into the complicated problem of tooth discoloration from pulp decomposition, the above fact should be remembered.

With the exception of the carbonate, the hydroxid, and the hypophosphite, all of the compounds of iron are freely soluble in water, but insoluble in alcohol. The so-called *scaled* salts are all ferric compounds of phosphoric acid, or the organic acids, citric and tartaric; they are rendered more soluble in combination with citrates, tartrates, and phosphates of the respective alkalies—ammonium, potassium, and sodium—and some are known as "soluble" salts. The scale salts are comparatively free from astringency, usually well borne by the stomach, and are used in medicine as mild and agreeable *hematinics*. The dose, with one exception (that containing strychnin), is 4 gr. (0.25 Gm.). The official Latin titles do not distinguish between the *ferrous* and *ferric* compounds, but they are so distinguished in the English titles. Iron is used in medicine: (1) in the form of metallic or elementary iron (Reduced Iron, U.S.P.); (2) in the ferrous or unoxidized form of combination—responding to tests for *ferrous ions* (ferrous carbonate in *mass* of ferrous carbonate and *pill* of ferrous carbonate, ferrous iodid in *syrup* of ferrous iodid, U.S.P.); (3) in trivalent or oxidized form, the ferric compounds—responding to tests for *ferric ions* (ferric chlorid in *tincture* of ferric chlorid, U.S.P.); and (4) complex compounds of iron. Complex (masked or nonionic) iron compounds are those compounds of iron wherein iron is part of a radical, and whose solutions do not respond to the ordinary tests for ferrous or ferric ions. Such compounds of iron do not have the astringent taste of simple iron solutions. As they are not decomposed by gastric digestion, they are also devoid of gastric effects; but, on the other hand, it has been claimed that certain hemoglobin-like compounds escape absorption altogether. It should be remembered that "masked" iron can often be administered in sufficient amounts and most economically by selecting a dietary rich in iron, such as red meat, egg-yolk, green vegetables, whole wheat, etc. The iron compounds used in dental therapeutics here follow.

FERRI SULPHAS—U.S.P.

(Ferrous Sulphate; Green Vitriol; $FeSO_4.7H_2O$.)

Ferrous sulphate occurs in the form of bluish-green, efflorescent prisms, odorless, having a saline, styptic taste. It is freely soluble in

water, insoluble in alcohol. The average dose is 1½ gr. (0.1 Gm.). The official preparations are:

Ferri Sulphas Exsiccatus, U.S.P. *Dose*, 1–3 gr. (0.06–0.2 Gm.).
Ferri Sulphas Granulatus, U.S.P. *Dose*, 1–3 gr. (0.06–0.2 Gm.).

Physiologic Action and Therapeutics.—Iron sulphate is an active astringent. It may be applied to *canker sores*, but is inferior to copper sulphate. It is frequently used as a deodorant for privies and cesspools.

FERRI SUBSULPHAS (Nonofficial)

(Ferric Subsulphate; Basic Ferric Sulphate; Monsel's Salt; $Fe_4O(SO_4)_5$.)

Ferric subsulphate occurs as a yellow, hygroscopic, astringent powder, freely soluble in water. There was formerly one official preparation:

Liquor Ferri Subsulphatis, U.S.P. IX (Monsel's Solution). *Dose*, 3–5 min. (0.2–0.3 cc.).

Physiologic Action and Therapeutics.—Monsel's salt or the formerly official solution (Monsel's solution) is a prompt and powerful styptic, and as such it has long been used in dentistry to control *hemorrhage* following the *extraction of teeth*. When the hemorrhage proceeds from a tooth-socket it is better to use the salt than the solution, for the reason that the hard black clots formed by the latter may conceal the deep-seated hemorrhage. The salt can be incorporated in moist cotton and, after washing the socket, the medicated cotton should be packed tightly into it. Sometimes it is necessary to hold the packing firmly for some time in order to control the hemorrhage. In recent years new products have been developed which serve the dentist in the control of hemorrhage far better than this salt of iron. These are *fibrin ferments* and *thromboplastic products*, and are discussed elsewhere.

FERRI CHLORIDUM—U.S.P.

(Ferric Chlorid; Iron Perchlorid; $Fe_2Cl_6.12H_2O$.)

Ferric chlorid occurs in orange-yellow, crystalline pieces, having an astringent taste. It is a highly deliquescent salt, and therefore freely soluble in water, also in alcohol. The official preparations are:

Liquor Ferri Chloridi, U.S.P. *Dose*, 3–10 min. (0.2–0.6 cc.).
Tinctura Ferri Chloridi, U.S.P. (from Liquor). *Dose*, 5–30 min. (0.3–2.0 cc.).

Liquor Ferri et Ammonii Acetatis, U.S.P. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Physiologic Action and Therapeutics.—Ferric chlorid is an active astringent and styptic. It is employed in the control of *hemorrhage*, after the *extraction of teeth*, *removal of small growths*, etc.

As a styptic in dental therapeutics, it is inferior to Monsel's solution or salt. The tincture has a deleterious action upon the teeth, and should be used about the mouth with caution.

Ferrum Dialysatum (Dialysed Iron).—This is a nonofficial preparation of iron oxychlorid from which acidulous matter has been separated by dialysis, hence the name, *dialysed iron*. It is a dark red, neutral liquid, without odor or taste. It has been employed freely as a local antidote in *arsenical poisoning*. Dentists have been prone to rely upon this agent when other remedies would serve better (see p. 379).

FERRI CARBONAS (Nonofficial)

(Ferrous Carbonate; $FeCO_3$.)

Ferrous or **iron carbonate** is an unstable compound which is readily converted into ferric hydroxid (hydrate) when moist and exposed to air—a characteristic of most *ferrous* compounds. The salt may be protected from oxidation and enters into the following official preparations:

Ferri Carbonas Saccharatus, U.S.P. *Dose*, 5–15 gr. (0.3–1.0 Gm.).

Massa Ferri Carbonatis, U.S.P. (Vallet's Mass). *Dose*, 3–5 gr. (0.2–0.3 Gm.).

Pilulæ Ferri Carbonatis, U.S.P. (Blaud's Pills, each containing not less than 1 gr. (0.069 Gm.) of pure Ferrous Carbonate). *Dose*, 1–3 pills.

Physiologic Action and Therapeutics.—Ferrous carbonate acts as a tonic, and the preparations containing it, being free from astringency, may be used whenever iron is demanded by the tissues. The preparations are especially useful in *anemia*.

FERRUM REDUCTUM—U.S.P.

(Reduced Iron; Iron by Hydrogen.)

Reduced iron occurs as a fine, grayish-black, insoluble powder, without odor or taste. It should contain not less than 90 per cent. of metallic iron. It is a valuable *hematinic*, as it is free from astringency and has little tendency to cause constipation. The average dose is 1 gr. (0.06 Gm.) given in the form of pills, capsules, or lozenges.

FERRI HYDROXIDUM CUM MAGNESII OXIDO—U.S.P.

(Ferric Hydroxid with Magnesium Oxid.)

Ferric hydroxid with magnesium oxid is made by adding ammonia water to a solution of ferrous sulphate, collecting and washing the precipitate, when magnesium oxid is added in excess. The preparation is used exclusively as an internal antidote in *arsenical poisoning*. It should be freshly made and given freely, while still moist, in tablespoonful doses or more every few minutes. The average dose is 4 fl. oz. (120.0 cc.).

FERRI IODIDUM (Nonofficial)

(Iron Iodid; FeI_2.)

Ferrous iodid occurs in grayish-white, crystalline masses; soluble in water with partial decomposition. It enters as an essential constituent into the following official preparation:

Syrupus Ferri Iodidi, U.S.P. (5 per cent.). *Dose*, 5–60 min. (0.3–4.0 cc.).

Physiologic Action and Therapeutics.—Iron iodid acts as an alterative, and as such is used in certain *syphilitic conditions*. The syrup is injurious to the tooth structure, and it should be taken through a tube, or given well diluted with instructions to thoroughly rinse the mouth after its administration.

FERRI HYPOPHOSPHIS (Nonofficial)

(Ferric Hypophosphite.)

This salt occurs as a white powder, odorless, and practically tasteless. It is but sparingly soluble in water. The average dose is 8 gr. (0.5 Gm). It is contained in the following preparation:

Syrupus Hypophosphitum Compositus, N. F. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

This preparation is adopted from the National Formulary, and is similar to a number of proprietary syrups of hypophosphites. The preparation is used as an alterative and hematinic.

PHOSPHORUS—U.S.P.

(P.)

Phosphorus occurs as a translucent, nearly colorless solid, of a waxy luster, and at ordinary temperatures having about the consistence of beeswax. When kept for some time the surface becomes red and occasionally black. When exposed to air it emits white fumes, visible in the dark, which have an odor somewhat like garlic.

Upon prolonged exposure to air it takes fire spontaneously. The drug should be carefully kept under water, in which it is practically insoluble, in strong, well-closed vessels. The average dose is $\frac{1}{120}$ gr. (0.0005 Gm.). The following preparation is official:

> Pilulæ Phosphori, U.S.P. (each pill contains $\frac{1}{100}$ gr.–0.0006 Gm.). *Dose*, 1–3 pills.

Physiologic Action.—Phosphorus stimulates the bone-forming tissues, when given in small doses, rendering the bones more dense, and diminishing the cancellous structure; if the administration of the drug is continued, the marrow-cavity becomes more or less obliterated. There has been a difference of opinion among investigators as to how this result was brought about. Some believed that an excess of phosphates was deposited, while others felt that it was due to a specific irritation of the bone-forming cells, causing stimulation. The latter theory is more nearly correct, for Wegner has shown by a series of experiments on growing animals fed with phosphorus, but deprived of phosphates, that the same hyperplasia in the bones resulted, but that the new tissue was soft and gelatinous instead of hard. The dominant action of phosphorus is upon the osseous system. Stevens claims, however, that there is considerable clinical testimony to show that the drug improves the nutrition of other tissues, especially of the nervous system. Phosphorus is extensively used in the manufacture of matches, and the fumes so common in these factories often produce the most serious results. Where dental caries is present extensive maxillary necrosis has been reported by Brophy and others, as well as great irritation of the conjunctivæ and the respiratory mucous membrane. In most match factories a strict rule is adopted requiring the employees to have their teeth examined at stated intervals and, if found necessary, put in order.

Poisoning and Treatment.—The effects of a toxic dose of phosphorus are not generally manifested for several hours after its ingestion. The earliest symptoms are intense abdominal pain, persistent vomiting, thirst, a garlicky taste in the mouth, restlessness, and prostration. At the end of twenty-four to thirty-six hours, these acute symptoms gradually subside, and the hope is raised that the patient will surely recover, but frequently after a lapse of a few hours, or even two or three days, the symptoms of the acute stage may recur. In these cases there is great weakness, the symptoms becoming more acute, mucus, bile, and occasionally disintegrated blood being contained in the ejected materials, which for a time retain the

odor and luminosity of phosphorus; jaundice develops; the liver becomes enlarged and painful, and the pulse grows very feeble. In fatal cases death generally occurs in from a few days to two weeks, and is often preceded by delirium, convulsions, stupor, and coma; fatty degeneration usually occurs of the tissues of the essential organs, such as the heart, liver, etc.

In the *treatment of phosphorus poisoning*, if the drug has recently been taken, emetics and purgatives are from the first necessary. Copper sulphate is considered the most efficient emetic as well as the best chemic antidote, since any excess forms with the phosphorus the insoluble copper phosphid. Since oily and fatty substances are active solvents for phosphorus, all such material should be withheld. Castor oil, then, as a cathartic, should not be used.

As prophylactic measures for the protection of workmen against phosphor-necrosis, masks covering the mouth and nose have been found serviceable, as well as the inhalation of the vapor of turpentine obtained by suspending a small vial of the fluid at the neck. As has been mentioned, the teeth should be examined, especially for caries, at stated intervals, since the presence of carious teeth favors the tendency to maxillary necrosis.

Therapeutics.—Phosphorus is employed as a tonic to the osseous tissues and in certain diseases of the nervous system that are dependent upon exhaustion rather than upon organic changes. In *neurasthenia* and *chronic nervous exhaustion* it is a useful therapeutic agent. Some cases of *neuralgia*, particularly of the fifth nerve and accompanied by great debility, may be relieved by full doses administered every four hours (Butler). The drug has proved efficacious in *caries*, *delayed union of fractures*, *osteomalacia*, and *rachitis* (rickets). In *functional impotence* from sexual excess, phosphorus is also a valuable remedy. The pill is considered the most stable, and therefore the best preparation in which to administer the drug. Some practitioners favor administering phosphorus in the form of zinc phosphid. It should also be given in pills, three times daily. *Dose*, $\frac{1}{12}$–$\frac{1}{6}$ gr. (0.05–0.01 Gm.).

ACIDUM PHOSPHORICUM—U.S.P.

(Phosphoric Acid; Orthophosphoric Acid; H_3PO_4.)

Under Phosphorus it was stated that when exposed to air the drug burns, emitting white fumes. Chemically considered, this means that phosphorus combines directly with oxygen to form phosphorus pentoxid (P_2O_5). This oxid is capable of combining chemi-

cally with one, two, or three molecules of water, forming thereby three different acids, as:

$P_2O_5 + H_2O = H_2P_2O_6 = 2HPO_3$, Metaphosphoric Acid.
$P_2O_5 + 2H_2O = H_4P_2O_7$, Pyrophosphoric Acid.
$P_2O_5 + 3H_2O = H_6P_2O_8 = 2H_3PO_4$, Orthophosphoric Acid.

These three acids show different reactions, act differently upon the animal system, and form different salts. The acid of phosphorus recognized by the United States Pharmacopeia is a colorless liquid, composed of 85 per cent. by weight of absolute orthophosphoric acid and 15 per cent. of water. It has a strong acid taste. There is an official diluted phosphoric acid (Acidum Phosphoricum Dilutum, U.S.P., 10 per cent.) which is usually employed when phosphoric acid is indicated, the average dose of which is 30 min. (2.0 cc.) in water.

Physiologic Action and Therapeutics.—The action of phosphoric acid is somewhat like that of the dilute mineral acids, and has no relation to the action of phosphorus itself. In medicine the drug is used to allay *thirst in diabetes* and *febrile diseases*, and to *promote gastric digestion*. The acid has practically no use in dental therapeutics, but is discussed here because phosphoric acid (modified somewhat) is the liquid combined with *zinc oxid* (cement powder) to make the *zinc phosphate cement*, so extensively used in dental practice. Nearly all of the phosphates found in nature are orthophosphates.

CALCII PHOSPHAS PRÆCIPITATUS (Nonofficial)

(Precipitated Calcium Orthophosphate; Bone Phosphate; $Ca_3(PO_4)_2$.)

Precipitated calcium phosphate occurs as a white, odorless, tasteless, amorphous powder; insoluble in cold water and alcohol. The average dose is 10 gr. (0.6 Gm.). There was one official preparation:

> Syrupus Calcii Lactophosphatis, U.S.P. IX (contains about 3 per cent. of the double soluble salt). *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Physiologic Action and Therapeutics.—Calcium phosphate may be taken as the type of the insoluble salts of calcium, which are so frequently referred to in dental literature as "lime-salts." Lime is calcium oxid, and as there is no such thing in chemistry as a salt of an oxid, this term, *lime-salts*, should be discarded. When taken internally, calcium phosphate, for the most part, resists absorption

and reappears in the stools; a small amount, however, is assimilated, and in case of a deficiency of phosphates in the food is appropriated by the tissues. Where the phosphates in the natural food-supply meet all physiologic requirements, any excess of the insoluble calcium salts is slowly excreted by the intestinal epithelium and kidneys. Food ordinarily contains more calcium phosphate than the body requires; it is, therefore, difficult to explain how the insoluble salts of calcium (phosphate and hypophosphite), administered as a remedy, can be of any physiologic importance. Stevens[1] states that the difficulty, however, is no greater than that which is encountered in attempting to explain the undoubted efficacy of iron in chlorosis, a disease that is certainly not dependent upon a want of iron salts in the food. There is no convincing evidence to show that the insoluble calcium salts are of much value in themselves as therapeutic agents. On theoretical grounds they have been prescribed to prevent the *rapid decay of teeth* during *pregnancy* and the *nursing period*, in *osteomalacia*, and in *rachitis*. They seem to exert a favorable influence on general nutrition in such diseases as *chlorosis*, *anemia*, *scrofula*, *tuberculosis*, *tertiary syphilis*, and *neurasthenia*. Calcium phosphate may be given in powders or capsules; the lactophosphate, being soluble, may be administered in the form of the formerly official syrup or in an emulsion of cod-liver oil.

As a vehicle for making pastes used in *capping pulps*, *bleaching teeth*, etc., the author formerly recommended combining precipitated calcium phosphate with thymol (2 per cent.). For the *protection of the dental pulp* and *filling the canals of pulpless teeth*, a new preparation under the name of *Dentinoid* has recently been suggested. This product contains calcium phosphate in the proportion as found in natural dentin, combined with bismuth subnitrate, thymol, thymol iodid and an inert resinous binder. Calcium phosphate is also a constituent of several dental pastes which are on the market. Its use in dentistry was first suggested by the author in an article appearing in the "Dental Review" on the Bleaching of Teeth in about 1900.

CALCII LACTOS—U.S.P.

(Calcium Lactate.)

Calcium lactate occurs as white, granular masses or powder. It is practically odorless, somewhat efflorescent and should contain not less than 70 per cent. and not more than 75 per cent. of calcium lactate ($Ca(C_3H_5O_3)_2$), corresponding to not less than 98 per cent. of

[1] Modern Materia Medica and Therapeutics.

the hydrated salt. One Gm. of calcium lactate is soluble in 20.0 cc. of water at the standard temperature (25°C.). It is practically insoluble in alcohol. The average dose is 15 grs. (1 Gm.). There are no official preparations.

Physiologic Action and Therapeutics.—At the present time much investigation is going on in both dentistry and medicine in relation to certain diseases which are claimed to be produced or augmented by "calcium deficiency." It is known that in certain pathologic conditions there is a deficiency of this metallic element. Just what the ultimate results of this investigation will be, time alone can tell. In the treatment of such conditions calcium lactate is added to such medicines or foods as cod liver oil and other substances, and it was because of this fact that the drug has here been considered.

CALCII HYPOPHOSPHIS—U.S.P.

(Calcium Hypophosphite; $Ca(PH_2O_2)_2$.)

Calcium hypophosphite occurs in colorless, transparent crystals, or small lustrous scales, having a bitter, nauseating taste. It is soluble in about 7 parts of water, insoluble in alcohol. The average dose is 8 gr. (0.5 Gm.). It enters as an important constituent into the following official preparation:

Syrupus Hypophosphitum, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).

Physiologic Action and Therapeutics.—The action of hypophosphites, of which the calcium salt is a fair representative, is similar to that of calcium phosphate, and they may be employed as therapeutic agents in the same class of cases in which the latter has been recommended. Calcium hypophosphite, being more soluble in water, may be assimilated more readily, but the same remarks hold true of this agent as were made of calcium phosphate in regard to the power of the system to utilize the agent in the constructive processes of the body.

OLEUM MORRHUÆ—U.S.P.

(Cod-liver Oil.)

Cod-liver oil is a fixed oil obtained from the *fresh livers* of *Gladus morrhua* and other species of *Gladus*. It occurs as a thin, pale yellow liquid, having a characteristic fishy odor and taste. It contains the glycerids of olein, palmitin, and stearin, traces of iodin, bromin, chlorin, phosphorus, sulphur, biliary salts, and several alkaloids

(leucomains). It is also rich in the fat soluble vitamins. No food product approaches cod-liver oil in the richness of its A and D vitamins; even butter contains only a fraction of the amount present in cod-liver oil. The average dose is 2½ fl. dr. (10.0 cc.). The official preparation is:

> Emulsum Olei Morrhuæ, U.S.P. (50 per cent.). *Dose*, 1–8 fl. dr. (4.0–30.0 cc.).

Physiologic Action.—From the constituents of cod-liver oil it may readily be seen that it is a food rather than a medicine, and is a true *restorative*. In moderate doses it improves the general nutrition, increases the number of red blood-corpuscles, and favors the accumulation of fat—a normal and necessary constituent of the body. Fat is the fuel used to supply energy, and the most active tissues and organs require the most fuel. Consequently, nerves, muscles, and glands are more abundantly supplied with fat than cartilage; and, in cases of starvation, those structures demanding the greater supply must have it, at the expense of the less highly organized and active tissues. This is illustrated in certain diseases—tuberculosis, for example. Butler[1] states that the blood contains about one-half of 1 per cent. of fat; the muscles, 3 per cent.; the brain, 8 per cent.; and the nerves, 22 per cent. This equilibrium must be maintained in order that the various cells of the body may possess sufficient vitality to physiologically resist the encroachments of disease and the invasion of pathogenic bacteria. It is rather difficult to digest and assimilate ordinary fat; this must be done before it can enter the various cells of the body and act as a food, and, consequently, be a source of energy. Cod-liver oil is more readily absorbed and oxidized than any other fat, due to the fact that it has already been prepared by the liver, and therefore partially elaborated; and also to the biliary salts which it contains, causing it to pass more readily through animal membranes.

Therapeutics.—Cod-liver oil is a valuable restorative in all *emaciating diseases* resulting in *anemia*. It is especially indicated as a nutritive tonic in *tuberculosis*. As a food it may be given in any case where fat is deficient, and therefore needed to supply energy to the tissues. It is best administered at the end of gastric digestion and about the time when the pancreatic secretion is well started. This is about 1½ to 2 hours after a meal. To give cod-liver oil before meals, as is frequently done, takes away all appetite and thus defeats the end sought.

[1] Text-Book of Materia Medica, Therapeutics and Pharmacology.

POTASSII IODIDUM—U.S.P.

(Potassium Iodid; KI.)

Potassium iodid occurs as colorless, transparent or translucent crystals or as a white granular powder, having a pungent, saline taste; soluble in 0.75 part of water, 2.5 parts of glycerin, and 22 parts of alcohol. The average dose is 3–5 gr. (0.2–0.3 Gm.), given well diluted after meals; but in tertiary syphilis often 1 dr. (4.0 Gm.) may be given with advantage. The drug is a constituent of Lugol's solution (Liquor Iodi Compositus, U.S.P.); also the tincture and ointment of iodin (Tincture Iodi, U.S.P. and Unguentum Iodi, U.S.P.).

Physiologic Action.—Potassium iodid is a true alterative and has a favorable action in a variety of morbid conditions. As is true with many drugs, potassium iodid, given in a single, moderate dose in health, produces no noticeable effects beyond a slight increase in the secretion of urine and some disturbance of the stomach, due solely to its local irritant property. The drug is rapidly absorbed from all parts of the digestive tract, and reappears in the secretions in less than fifteen minutes after its ingestion. By far the greater portion is eliminated through the kidneys, but small quantities escape in almost every secretion of the body, as in the saliva, milk, perspiration, and even the tears. There is little doubt that a small quantity of the drug is retained, for a time at least, by the cells of the body and that a *cumulative* action may result, for its continuous use is generally followed, sooner or later, by a group of symptoms known as *iodism*. This condition has previously been mentioned, and in this instance results from the local irritant effects of free iodin, into which a portion of the iodid appears to be converted. There is a remarkable variance in the susceptibility of individuals to the iodids, and idiosyncrasies are frequently encountered. The amount of the drug, therefore, required to induce iodism depends upon the subject. Daily doses of from ¼–½ oz. (7.5–15.0 Gm.) are sometimes well borne, and, on the other hand, doses of from 2–3 gr. (0.13–0.2 Gm.) a day may soon produce intense discomfort.

Therapeutics.—Potassium iodid is the one drug relied upon in nearly all cases where an alterative drug is indicated. Its best effects are observed in *tertiary syphilis*, in which stage of the disease its efficacy is equal to that of mercury in the *secondary stage*. The initial dose should be small, and the amount gradually increased until improvement follows or symptoms of iodism appear. It is necessary in syphilis to continue the treatment for six months or a year, and even longer, if permanent results are to be expected.

In *acute alveolar abscess* the author has secured excellent results in many cases by the repeated internal administration of small doses of potassium iodid. The nauseating taste can be masked by dissolving 1 dr. (4.0 Gm.) of the drug in 3 fl. oz. (90.0 cc.) of the compound syrup of sarsaparilla or syrup of wild cherry. One teaspoonful in water can be given every two hours until three or four doses have been taken.

Potassium iodid has been combined with expectorants, and used with advantage in *chronic bronchitis*, when the sputum is composed of thick, viscid mucus. In *morbid conditions* of the mucous membrane in *chronic catarrh* the drug is also useful. In *actinomycosis*, occurring in man, the drug has been used internally with complete success as a curative remedy in a number of cases (Stevens).

Potassium iodid is highly efficacious in *chronic metallic poisoning*, especially from lead and mercury, as it aids in the elimination of the metal by forming with it in the tissues a double soluble salt.

OTHER IODIDS

The iodids of several metals are used in medicine. **Sodium, ammonium,** and **strontium iodid** resemble potassium iodid in their action, and may be used for the same purposes; but they do not possess in the same degree the virtues ascribed to the potassium salt. Zinc iodid has different properties, due to the zinc *ion*, and has been elsewhere discussed.

HYDRARGYRUM—U.S.P.

(Mercury; Quicksilver; Hg.)

Mercury is a shining, silver-white, heavy metal, without odor or taste. It is a liquid at the ordinary temperature, and easily divided into spherical globules; but when cooled to — 40°C. it forms a ductile, malleable mass. The metal is insoluble in ordinary solvents, but miscible with saccharine substances and fats, through which, by tritutration, the globules may be so finely divided as not to be discernible by the naked eye, in which condition the drug is very active medicinally.

Mercury is largely used in therapeutics in the form of its compounds, but there are several official preparations in which metallic mercury is incorporated, after being reduced to the finely divided condition. They are:

> Hydrargyrum cum Creta, U.S.P. (contains 38 per cent. of Mercury). *Dose*, ½–10 gr. (0.03–0.6 Gm.).
> Unguentum Hydrargyri Fortius, U.S.P. (contains 50 per cent. of Mercury).

Unguentum Hydrargyri Mite, U.S.P. (Blue Ointment; Unguentum Hydrargyri Dilutum, U.S.P. IX; contains 31 per cent. of Mercury; made by mixing Ointment of Mercury, 2; Petrolatum, 1 part).
Massa Hydrargyri, U.S.P. (pill mass of Mercury; contains 33 per cent. of Mercury).
Oleatum Hydrargyri, U.S.P. (contains 25 per cent. of Mercury).

Physiologic Action.—Mercury is an alterative and tonic. Every dentist should be thoroughly familiar with the action and effects of this metal. When small doses of an unirritating preparation of the drug are given continuously for a certain length of time, the first effects are observed in the mouth, for it has a selective influence upon the gums, jaws, and adjacent structures. There is produced an increased flow of saliva, fetor of the breath, redness of the gum margins, and pericementitis, causing soreness of the teeth when the jaws are forcibly brought together. If the drug is not withdrawn upon the appearance of these symptoms, the condition gradually grows worse; salivation becomes excessive (continual drooling), the gums become swollen and spongy, the teeth are loosened in their sockets and may be easily extracted with the fingers, the tongue and parotid glands enlarge—the former sometimes to the extent that it protrudes from the mouth, and, finally, the soft tissues slough away, necrosis of the bones sets in, and large sequestra form. This group of symptoms is known as *ptyalism* or *salivation*. In these cases the general health is naturally affected, the patient becoming pale and losing flesh. Chronic mercurial poisoning occurs most frequently in workmen who handle the metal or who are exposed to its fumes, such as makers of thermometers, mirrors, scientific instruments, etc. It is too frequently induced, however, by the prolonged use of mercury as a medicine.

The drug is supposed to enter into the composition of the cell by combining with the nucleinic acid, forming mercury nucleinate. It is absorbed gradually, and although every secretion of the body contributes to its general expulsion from the system, traces of the drug have been detected in the urine months after its use had been discontinued. It is, therefore, one of the slowest drugs known to be eliminated, and its *cumulative* action is a well-established fact.

Treatment of Poisoning.—If the symptoms of ptyalism are not too pronounced, discontinuance of the mercury and mouth hygiene usually clear up the symptoms. In more severe cases, besides discontinuing the use of mercury and employing prophylactic measures,

certain medicinal remedies are indicated. The *teeth should not be extracted*, unless so loose that they virtually fall out. Potassium chlorate can be dissolved in cinnamon water (10 gr.–0.6 Gm. to the fl. oz.—30.0 cc.) and used as a mouth-wash. Atropin, in medicinal doses, may be used twice daily to control the flow of saliva. The internal administration of potassium iodid is recommended, as it aids in the elimination of mercury by forming with it in the tissues the double soluble salt. Where necrosis of the bones is evident, Cook and Mawhinney recommend the local application of a 50 per cent. solution of phenolsulphonic acid. This agent acts as a stimulant and hastens the formation of the sequestra. When the pain is very severe, morphin may be given; and tonics are indicated to combat the exhaustion and anemia.

Therapeutics.—Mercury and its compounds are used in general therapeutics for a variety of purposes. They act as antisyphilitics, antiparasitics, disinfectants, cathartics, and diuretics, as well as alteratives and tonics. The early methods of administering mercury were by mouth and inunction. The oral method continues to be popular, but often causes troublesome gastrointestinal symptoms. The inunction method obviates the digestive disturbances, but the amount of the drug absorbed cannot be well controlled and it is practically impossible to introduce an amount sufficient for *syphilis*. In recent years the attempt to improve mercurial therapy has been mainly along two lines: The perfection of the hypodermic usage, and the introduction of the organic compounds. The organic compounds of mercury, such as mercurol (mercury with nucleinic acid from yeast, containing 20 per cent. of metallic mercury), are said to be less irritating to the gastrointestinal tract than the inorganic salts. The use of such agents, however, is rather experimental, and further investigation is needed to determine their real value.

In *syphilis*, mercurials and the iodids act as *specifics*. Sollmann[1] states that the use of the former, as yet, rests entirely upon an empirical basis. It is not even known whether the action of mercury here is due to specific toxicity for the germ of syphilis (Spirocheta pallida), or whether it is due simply to the general effects upon metabolism. The former seems to be the case. There is no reason to doubt that mercury is not only palliative, but curative, in the *secondary stage of syphilis*, congenital as well as acquired; while it is useless in the first and third stages. The first stage is best treated expectantly, or now with salvarsan, "606;" the third, with iodids. Syphilograhers have learned from sad experience that mercury can

[1] A Text-Book of Pharmacology.

be pushed much further in the treatment of secondary syphilis without producing ptyalism if the mouth has first been placed in a hygienic condition, *i.e.*, if all irritants (deposits, overhanging fillings, etc.) have been removed by thorough prophylactic treatment.

The preparations most frequently prescribed in syphilis are mercury with chalk and compounds, like the bichlorid, biniodid, and protiodid. As mentioned (page 218), the organic compounds of mercury are also used, and under observation. The ointments are used by inunction.

In *pediculosis pubis* (crab-lice) the parasites are quickly destroyed by rubbing into the affected parts a small amount of blue ointment.

It is the compounds of mercury that are most valuable in dental therapeutics. Mercury, however, is used extensively in the amalgamation of dental alloys in the preparation of dental amalgams, which occupy a prominent place in dental practice as filling material for teeth.

Many homeopathic practitioners object strenuously to the use of amalgams for filling the cavities in the teeth of their patients; some go so far as to order all amalgam fillings removed and fillings of other material substituted, in the belief that the amalgam filling is gradually worn away and enough mercury is thus carried into the stomach and absorbed to cause systemic disturbances. The idea is certainly far-fetched, for while metallic mercury can be separated from an amalgam by high compression or heat, it, nevertheless, is combined in the amalgam by a more or less definite chemic union. The author has no positive proof to show that mercury cannot be thus absorbed; but by close observation in a long clinical experience no constitutional disturbances from this source have been discovered. The same objections are offered to the wearing of a red-rubber denture, because mercury compounds are used as pigments for coloring the rubber. Surely, with the high heat necessary for vulcanization, the mercury would combine with the other elements to form such insoluble (nonabsorbable) compounds that there would be no danger of systemic disturbances from this source.

COMPOUNDS OF MERCURY

Mercury, like iron, forms two series of compounds which are not distinguished in their Latin titles as they are in their English titles: *mercurous* and *mercuric*. The former are sparingly soluble and less active, while the latter are more readily soluble in water and alcohol and so irritant as to be classed with the *poisons*. The

two classes also differ somewhat in regard to their physiologic activity. The mercurous compounds, of which the chlorid (calomel) is a type, powerfully stimulate the glandular system and are antiseptics, alteratives, and cathartics. The mercuric compounds, of which the chlorid (corrosive sublimate) is a type, are potent alteratives, and powerful antiseptics and disinfectants. It is easy to distinguish between the two classes by the different coloration produced with lime-water (liquor calcis). The former (ous) forms a black precipitate, the latter (ic), a yellow.

HYDRARGYRI CHLORIDUM MITE—U.S.P.

(Mild Mercurous Chlorid; Calomel; HgCl.)

Calomel occurs as a white, amorphous powder, without odor or taste. It is insoluble in all ordinary solvents. The average dose as a laxative is 2½ gr. (0.15 Gm.); as an alterative, ¼ gr. (0.015 Gm.). It is an important constituent of the following official pill:

> Pilulæ Hydrargyri Chloridi Mite Compositæ, U.S.P. (Pilulæ Catharticæ Compositæ, U.S.P. IX, each contains Calomel, 1 gr.—0.06 Gm., with Gamboge, Compound Extract of Colycinth, and Resin of Jalap). *Dose*, 1–3 pills.

Physiologic Action and Therapeutics.—Externally applied, calomel acts as a stimulant, antiseptic, and desiccant. Internally administered, it acts as a cathartic, diuretic, and antisyphilitic. Zinc ointment to which calomel, 10 gr. (0.6 Gm.) to the ounce (32.0 Gm.), has been added makes an excellent application in *subacute* and *chronic eczema*, and *indolent venereal ulcers* are desiccated and much improved by dusting them with calomel.

Calomel acts as a laxative or purgative, according to the way in which it is administered and the susceptibility of the patient. It is a rather peculiar cathartic in that its effect does not increase in direct ratio with the dose, as is true with most cathartic drugs. Small doses repeated every half-hour until 1 or 2 gr. (0.065–0.13 Gm.) have been taken generally operate more freely than a dose of 10 gr. (0.6 Gm.) taken at once. Calomel produces a thorough evacuation, the stools being large and loose, and usually charged with undecomposed bile. Whether the drug increases the quantity of bile formed in the liver or simply hastens the flow through the intestines and prevents its reabsorption is an unsettled question. Experimental and clinical evidence point more strongly to the latter assumption.

In cases of a *sluggish liver*, the drug has been used in small, oft-repeated doses (1/10 gr.–0.006 Gm.) to advantage. It is a true

cholagogue and no remedy is so useful as calomel in the condition known as "*biliousness*," which is characterized by a thickly coated tongue, fetid breath, heavy urine, headache, and depression of spirits. In these cases $\frac{1}{6}$ gr. (0.01 Gm.) may be given every fifteen or twenty minutes until 1 gr. (0.06 Gm.) has been taken. If the bowels do not move freely, it is well to follow the mercurial with a saline cathartic (Epsom salts or a Seidlitz powder).

Incompatibles.—Calomel is incompatible with hydrochloric acid, chlorids, chlorates, iodids, bromids, and lime-water, as well as with alkalies, alkaline carbonates, iron, lead, and copper.

HYDRARGYRI CHLORIDUM CORROSIVUM—U.S.P.

(Mercuric Chlorid; Mercury Bichlorid; Corrosive Sublimate; $HgCl_2$.)

Mercuric chlorid might well have been discussed under the heading of Disinfectants, as it is for this purpose only that it is used in dental therapeutics; but it was left that it might be considered and discussed here with the other compounds of mercury. It occurs in the form of colorless, odorless crystals or a fine white powder, having an acrid, metallic taste. It is soluble in 13 parts of water and in 3 parts of alcohol. The average dose is $\frac{1}{20}$ gr. (0.003 Gm.). The U.S.P. IX for the first time recognized an official tablet. This is also official in the U.S.P. X:

> Toxitabellæ Hydrargyri Chloridi Corrosivi, U.S.P. Externally (see p. 21).

Physiologic Action and Therapeutics.—Mercuric chlorid, called usually bichlorid or corrosive sublimate, acts as an antisyphilitic and tonic, as well as an energetic disinfectant. It is for the latter action that it is extensively employed in dental as well as in general therapeutics.

The drug is capable of destroying most bacteria in solutions as dilute as 1 : 20,000, and their spores in solutions of 1 : 10,000. Certain germs, however, like the anthrax bacillus, are more resistant to its action, and stronger solutions are necessary for their complete destruction. On the whole, it has been the most popular of the disinfectants, and took first rank with surgeons for use upon the *skin of the patient* and *the hands of the operator* and *for irrigating infected wounds and cavities*. For the patient's skin and the surgeon's hands, solutions of from 1 : 1,000 to 1 : 500 have been employed; for large wounds and cavities, 1 : 10,000 to 1 : 5,000; and for small wounds, 1 : 2,000. The

drug is an irritant, and should not be used, even in dilute solutions, on serous membranes. It should be observed that solutions of mercury bichlorid are not used to-day for irrigating wounds to the extent that they were in times past.

Mercuric chlorid has three disadvantages as a disinfectant: it is extremely poisonous; it is readily converted into an inert compound (mercury albuminate) in the presence of albuminous matter, and it is destructive to metal instruments. This last drawback is a serious objection in dental therapeutics; for, were it not for this fact, the drug would be an ideal disinfectant for instruments. It is energetic, soluble, and cheap. Tartaric or citric acid may be advantageously combined with bichlorid solutions to prevent the mercuric salt from forming an insoluble albuminate with the albumin in the tissues. Compressed tablets of mercuric chlorid, each containing 7½ gr. (0.5 Gm.) with tartaric or citric acid are in common use. One of these tablets dissolved in a pint (480.0 cc.) of water makes a 1 : 1,000 solution.

For *sterilizing infected dentin* a 1 : 500 solution is an excellent remedy. The author suggests keeping the pure drug in papers (chartulæ) each containing 1 gr. (0.06 Gm.). By so doing, an approximate 1 : 500 solution may be conveniently made at any time by dissolving the contents of one paper in one ounce (30.0 cc.) of distilled water. Ordinary water, containing traces of calcium salts, partially precipitates the bichlorid in the form of mercuric oxid. In applying this solution to the tooth-structure with a pledget of cotton and pliers, the latter should be dried immediately after the application on a clean, aseptic doily, to prevent the action of the mercury upon the instrument.

As a parasiticide, mercury bichlorid is a valuable remedy in *pediculosis pubis* and *ring-worm*. In these affections, 2–4 gr. (0.13–0.26 Gm.) to the ounce (30.0 cc.) of tincture of benzoin make an excellent application.

In *syphilis* the drug may be given in pill or in solution. One-twentieth of a grain (0.003 gm.), gradually increased to $\frac{1}{12}$ gr. (0.005 Gm.), may be given after meals.

HYDRARGYRI IODIDUM RUBRUM—U.S.P.

(Red Mercuric Iodid; Mercury Biniodid; HgI_2.)

Mercury biniodid occurs as a bright red, amorphous powder, without odor or taste. It is practically insoluble in water, soluble in 116 parts of alcohol, and freely soluble in solutions of potassium

iodid. The average dose is $\frac{1}{20}$ gr. (0.003 Gm.). There is one official preparation:

Liquor Arseni et Hydrargyri Iodidi, U.S.P. (Donovan's Solution; 1 per cent. of each Iodid). *Dose*, 1–5 min. (0.06–0.3 cc.).

Physiologic Action and Therapeutics.—Mercury biniodid resembles the bichlorid in its action and effects. In the *late secondary stage of syphilis* it may be combined to advantage with potassium iodid. Stevens[1] recommends the following formula: Mercury biniodid, 1 gr. (0.06 Gm.); potassium iodid, 3 dr. (12.0 Gm.); water, 2 fl. oz. (60.0 cc.); compound syrup of sarsaparilla, sufficient to make 4 fl. oz. (120.0 cc.). The dose is a dessertspoonful in water after meals.

Donovan's solution is given with benefit in medicinal doses as an alterative in *chronic rheumatism*, *tuberculosis*, *adenitis*, *tertiary syphilis*, and during *convalescence* in many *exhaustive diseases*.

HYDRARGYRI IODIDUM FLAVUM—U.S.P.

(Yellow Mercurous Iodid; Mercury Protiodid; Green Mercury Iodid; HgI.)

Mercury protiodid occurs as a yellow, amorphous powder. It is insoluble and without odor or taste. The average dose is $\frac{1}{6}$ gr. (0.01 Gm.).

Physiologic Action and Therapeutics.—Mercury protiodid, being an *ous* compound is far less irritant than the bichlorid or biniodid. It is considered the best compound of mercury for use in *syphilis*, and should be given in pills or capsules to which a little opium may be added in case colic or diarrhea is induced by its ingestion.

Mercurol (Mercury Nucleinate) is an organic compound of mercury with nucleinic acid from yeast. It contains 20 per cent. of metallic mercury, and occurs as a brownish-white powder; soluble in water (warm water), insoluble in alcohol. The average dose is 1 gr. (0.06 Gm.).

The drug does not coagulate albumin; it has marked bactericidal power, and possesses the pharmacologic action of the soluble compounds of mercury. It is recommended as a local antiseptic and as an antisyphilitic remedy.

Sublamin (Mercuric Sulphate-ethylenediamin; $HgSO_4.2C_2H_4(NH_2)_2.2H_2O$).—This compound is composed of one molecule of mercuric sulphate and two molecules of ethylenediamin (a com-

[1] Modern Materia Medica and Therapeutics.

pound of ethylene and ammonia). It contains about 44 per cent. of metallic mercury, and occurs in white needles, odorless, but possessing a very disagreeable taste; readily soluble in water and in 10 parts of glycerin, sparingly soluble in alcohol. It is only used externally as a disinfectant, similar to mercuric chlorid, over which it has the advantage of being nonirritating, more penetrating, and readily soluble. A 1:200 solution is an excellent remedy for the immediate *sterilization of infected dentin*. The drug will attack steel instruments, and the same precautions must be observed here as with mercuric chlorid. It is used in 1:1,000 solution for hand disinfection, etc. By a carefully conducted series of experiments, Mawhinney has shown that the time required for a 1–200 solution to sterilize a broach was two minutes, and he recommends this strength solution for sterilizing steel instruments. The experience of the author with sublamin has proved it to be a good disinfectant, but that it attacks steel instruments immersed in its solution for any length of time.

Incompatibles.—Sublamin is incompatible with sodium chlorid and should not be exposed to air.

HYDRARGYRI OXIDUM FLAVUM—U.S.P.

(Yellow Mercuric Oxid; HgO.)

Mercuric oxid occurs as a light orange-yellow, odorless, amorphous, heavy, impalpable powder. It is stable in the air, but darkens on exposure to light. The drug is practically insoluble in water, and insoluble in alcohol. It is not used internally. There is one official preparation:

Unguentum Hydrargyri Oxidi Flavi, U.S.P. (1 per cent.).
In the U.S.P. IX this ointment contained 10 per cent.

Physiologic Action and Therapeutics.—The drug has mildly astringent, antiseptic and stimulating properties. The official ointment is an excellent remedy to use in cases of *reddened or granulated eyelids*, as so frequently occurs with dentists whose eyes are tested severely in their work.

ARSENUM (Nonofficial)

(Arsenic; As.)

Metallic **arsenic** is not official, for as such it is not employed as a medicine. The chief compound used in therapeutics, especially

dental therapeutics, is arsenic trioxid, which has been fully discussed as a devitalizing agent under Caustics. Certain salts of arsenous acid (arsenites) and arsenic acid (arsenates) are also used. The following compounds and preparations containing arsenic in combination are official:

Arseni Trioxidum, U.S.P. *Dose*, 1/60–1/20 gr. (0.001–0.003 Gm.).

Liquor Acidi Arsenosi, U.S.P. (contains 1 per cent. of Arsenic Trioxid and 5 per cent. of dilute Hydrochloric Acid). *Dose*, 1–5 min. (0.06–0.3 cc.).

Liquor Potassii Arsenitis, U.S.P. (Fowler's Solution; contains the equivalent of 1 per cent. of Arsenic Trioxid and 3 per cent. of compound tincture of Lavender). *Dose*, 1–5 min. (0.06–0.3 cc.).

Arseni Iodidum, U.S.P. *Dose*, 1/30–1/10 gr. (0.002–0.006 Gm.).

Liquor Arseni et Hydrargyri Iodidi, U.S.P. (Donovan's Solution). *Dose*, 1–5 min. (0.06–0.3 cc.).

Physiologic Action and Therapeutics.—The action and uses of arsenic trioxid have been elsewhere considered. Arsenic in therapeutic doses acts as an alterative by favoring nutrition. Just how the action is brought about is not well understood.

The drug is used internally in a number of quite diverse pathologic conditions. Its use, however, is purely empirical. It stands next to iron in the treatment of anemia. Fowler's solution, although not curative, is the most efficient remedy in *pernicious anemia*. In *neuralgia* dependent upon anemia, arsenic is valuable. The dose should be gradually increased until symptoms of saturation appear. No general tonic, except cod-liver oil, is so efficacious as arsenic in *pulmonary tuberculosis*. The drug has long been used with reported good results in *diabetes mellitus*. It is an excellent alterative in *periodontoclasia* associated with chronic *rheumatism* or the *gouty diathesis*. The prolonged use of arsenic (1/100–1/50 gr.—0.0006–0.0012 Gm.) has been spoken of in the highest terms in *myocardial degeneration* and *angina pectoris*. In these cases it may be combined advantageously with strychnin, and sometimes also with digitalis (Stevens).

Individuals vary considerably in their susceptibility to the action of arsenic, therefore it is best to begin with small doses of the drug and gradually increase them as occasion demands. The indications of saturation are puffiness under the eyes, especially noticeable in the morning, and looseness of the bowels with colicky pains. For pills arsenic trioxid is generally selected, and for solutions to be taken

internally the solution of potassium arsenite (Fowler's solution). Sodium arsenite is extensively used in exterminating ants and noxious weeds. For killing ants 12 grains of the salt is added to one pound of sugar made into a rather thick syrup. This solution should be placed on a sponge in perforated cans in selected places. For exterminating noxious weeds a $\frac{1}{1000}$ solution of sodium arsenite is used as a spray.

Incompatibles.—Arsenic is incompatible with salts of iron, silver, copper, and ammonium, magnesium, calcium, and tannic acid.

Arsphenamin or Salvarsan, "606."—This is a complex arsenic compound, the hydrochlorid of 3-diamino-4-dihydroxy-l-arsenobenzene, corresponding to 31.57 per cent. of arsenic. The average dose is 5 gr. (0.3 Gm.).

Salvarsan is useful as a specific remedy for *syphilis* in all stages. It is claimed that the drug is especially beneficial in those cases which respond slowly to mercury and iodids; and that it is useful in all *spirillum affections*, such as *malaria*. It is also said to be an available substitute for arsenic in the treatment of *diseases of the skin* and *nerves*, and in the *anemias*. According to available data, in *incipient tabes*, *early paralysis*, and *epilepsy* due to syphilis, the drug can be employed with the prospect of beneficial results only in those cases where its use is begun immediately after the first symptoms of the secondary disease have appeared. **Neoarsphenamin** or **Neosalvarsan** is a similar and later compound in which the arsenic content of three parts is approximately equal to 2 parts of salvarsan. It is merely a soluble compound of salvarsan and its action and uses are the same.

Contraindications.—Salvarsan preparations are contraindicated in severe disturbances of the circulatory organs, advanced degenerations of the central nervous system, fetid bronchitis, and cachexias, unless these are a direct result of syphilis; also in patients who have a pronounced idiosyncrasy against arsenic.

SARSAPARILLA—U.S.P.

Sarsaparilla is the *root* of *Smilax officinalis* and other species of *Smilax*, climbing evergreens growing in swampy forests of Mexico and as far south as the northern portion of Brazil. It contains several glycosids—*parillin*, *saponin*, and *sarsa-saponin*. The average dose is 30 gr. (2.0 Gm.). The following preparations are official:

Fluidextractum Sarsaparillæ, U.S.P. *Dose*, ½–2 fl. dr. (2.0–8.0 cc.).

Syrupus Sarsaparillæ Compositus, U.S.P. (contains fluid extract Sarsaparilla, 20; fluid extract Glycyrrhiza, 1.5; fluid extract Senna, 1.5; Oil of Sassafras, Oil of Anise, Methyl Salicylate, of each, 0.02; Alcohol, 1.9; Syrup, to make 100). *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Physiologic Action and Therapeutics.—Sarsaparilla owes its pharmacologic activity entirely to the saponins which it contains. The drug has been empirically used as an alterative in *syphilis* and *tuberculosis* for centuries, but this view of its action is not accepted at the present time, and if it possesses any action at all it is simply that of a very mild nauseant (Sollmann). It is chiefly used in the form of the compound syrup as a pleasant vehicle for potassium iodid, potassium bromid, and certain salts of mercury.

ECHINACEA (Nonofficial)

(Cone Flower.)

Echinacea is the *dried root* of *Echinacea angustifolia*, a perennial herb growing in the central and western portions of the United States. A fluid extract may be obtained, the dose of which is from 15–30 min. (1.0–2.0 cc.). The dose of specific echinacea (tincture) is from 5–30 min. (0.3–2.0 cc.). *Echafolta* is a purified, assayed form of echinacea. The dose is the same. Externally or for surgical purposes, it is considered greatly superior to any other preparation of echinacea, and is prescribed for the same conditions.

Echinacea was known to the Indians as a cure for snake poison. The experiments with the drug have been confined almost entirely to the eclectic school of medicine, and remarkable properties, almost bordering on the miraculous, are ascribed to it.

Physiologic Action.—Applied to the mucous membrane, a warm and tingling sensation is at once experienced. It is similar to that of aconite, without the sedative effect. The sensation persists for some time, even though the throat is gargled, and the agent entirely removed. The drug actively promotes the flow of saliva, and if swallowed, the warmth and tingling extend down the esophagus to the stomach, but no further unpleasant influence is observed. In a short time diaphoresis is observed, and the continuation of the remedy stimulates the kidneys to increased action. All of the glandular organs seem to respond to its stimulating influence, and their functional activity is increased. The stomach is improved in its function, the appetite increases, the food is more perfectly digested, the bowels operate better, and absorption, assimilation, and general

nutrition are materially improved. It encourages secretion and excretion, preventing further autointoxication, and quickly correcting the influence in the system of any that has occurred. It stimulates retrograde metabolism, or tissue waste, more markedly than any other single remedy known.

There are but few subjective symptoms from large doses of the drug. It is apparently nontoxic, and, to any unpleasant extent, nonirritant. It has a marked effect upon the nervous system, but its action here has not yet been determined (Ellingwood).

Therapeutics.—Hewitt, Cahill, and others have recommended the drug in dental therapeutics. Some enthusiasts go so far as to recommend the use of the drug in almost every disease to which the body is heir.

The drug has been used in *acute alveolar abscess* to prevent the formation of pus, or after pus-formation to hasten its evacuation. In *septicemia* (blood-poisoning), it is claimed to be almost a specific. In *ulcerative stomatitis*, *sore throat or mouth* of any character, the local application of echafolta is prompt and effectual.

CALCII SULPHIDUM CRUDUM (Nonofficial)

(Sulphurated Calcium; Crude Calcium Sulphid.)

Sulphurated calcium is a mixture containing at least 60 per cent. of calcium sulphid, together with calcium sulphate and varying proportions of carbon. It occurs as a pale gray powder, having a nauseating, alkaline taste and a faint odor of hydrogen sulphid. It is but slightly soluble in water and insoluble in alcohol. Exposure to air causes gradual decomposition. The average dose is 1 gr. (0.06 Gm.), in pills, tablets, or capsules. The drug was official in the U. S. P. IX.

Physiologic Action and Therapeutics.—The action of calcium sulphid is not well understood. Its power of *preventing and arresting suppuration* was first mentioned by Ringer. It has been found especially useful in *boils* and *carbuncles*. Excellent results are obtained in *follicular tonsillitis* and *quinsy* by giving small doses ($\frac{1}{20}$ gr.–0.003 Gm.) at short intervals. Harlan recommended giving the drug in doses of $\frac{1}{10}$ gr. (0.006 Gm.), at short intervals, in *acute alveolar abscess* and other *suppurative conditions*, claiming that it prevented the formation of pus, if given early enough, or, if too late for this, that the agent hastened the evacuation of the pus. Only fresh preparations should be employed on account of the liability of the drug to deteriorate.

AURI ET SODII CHLORIDUM (Nonofficial)

(Gold and Sodium Chlorid; $AuCl_3 + NaCl$)

This preparation is a mixture of equal parts, by weight, of dry gold chlorid and sodium chlorid. It is an orange-yellow powder, deliquescent, and of a saline and metallic taste; freely soluble in water. The average dose is $\frac{1}{12}$ gr. (0.005 Gm.), in pill.

Physiologic Action and Therapeutics.—Gold and sodium chlorid is supposed to act as an alterative, tonic, and stimulant to the digestive system. It has been recommended in a number of diseases where an alterative and tonic effect is desired, but it is of doubtful value. Solutions of gold chlorid have been recommended by Ames for cauterizing *exposed sensitive cementum*, and he claims that its effect is nearly equal to that of silver nitrate without the discoloration.

A gold plating solution advised by Dr. C. S. Case is made by dissolving 30 gr. (2.0 Gm.) of gold chlorid in one quart (1L.) of hot distilled water, and adding potossium cyanid (c.p.) until the solution is cleared. This should be used cold or slightly warmed. Use for an anode a piece of pure gold plate about two inches square. This should be removed from the solution when not in use. The parts or material plated may be polished with whiting on a soft hair brush wheel.

DIGESTANTS

The mouth and the stomach are intimately connected and closely related; so much so that pathologic conditions in one often predispose to disease in the other. It is therefore important that the dentist be familiar with the action and uses of certain agents which materially assist in the digestion of food. Those not discussed under other headings will here be considered. They are:

Pepsin.	Malt.
Pancreatin.	Papain.

PEPSINUM—U.S.P.

(Pepsin.)

Pepsin is a proteolytic ferment or enzyme obtained from the glandular layer of *fresh stomachs* from healthy pigs. It occurs as a yellowish-white, amorphous powder, or in thin, pale yellow scales, having a faint odor and a slightly acidulous or saline taste. It is soluble in 50 parts of water, more so in water acidulated with hydrochloric acid, and insoluble in alcohol. The Pharmacopeia of the

United States requires the drug to be capable of digesting not less than 3,000 times its weight of freshly coagulated and disintegrated egg albumin. The average dose is 8 gr. (0.5 Gm.)

Physiologic Action and Therapeutics.—Pepsin is an excellent digestant, being a normal constituent of the gastric juice, and in the presence of hydrochloric acid (a natural acid of the stomach) it digests the proteid elements of the food, converting these insoluble substances into albumoses, and finally into soluble peptones. The drug is given in cases where there is a lessened secretion of gastric juice, as in *atonic dyspepsia*, *cancer of the stomach*, and *gastric ulcer*. Many organic acids, alcohol, and alkalies impair the proteolytic action of pepsin.

PANCREATINUM—U.S.P.

(Pancreatin.)

Pancreatin is a mixture of enzymes naturally existing in the *pancreas* of warm-blooded animals, and is obtained from the fresh pancreas of the hog or the ox. It consists principally of *amylopsin*, *trypsin*, and *steapsin*. To be up to the official standard it should be capable of converting not less than 25 times its weight of starch into water-soluble substance (dextrose). It occurs as a cream-colored powder, slowly but not completely soluble in water, insoluble in alcohol. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action and Therapeutics.—The action of pancreatin is due to the active enzymes which it contains, of which trypsin digests proteids, amylopsin acts upon starches, and steapsin emulsifies fats and oils, resolving them into fatty acids and glycerin. The drug, like pepsin, is used as an artificial digestant in *certain disorders of the stomach* wherein digestion is impaired.

MALTUM—U.S.P.

(Malt.)

Malt is the *grain* of one or more varieties of *Hordeum vulgare* (barley), partially germinated artificially, and then dried. It contains amylolytic enzymes. The extract is official:

Extractum Malti, U.S.P. *Dose*, 4 fl. dr. (15.0 cc.).
Fluidextractum Malti, N.F. (contains 25 per cent. vol. alcohol). *Dose*, 2 fl. dr. (8.0 cc.).

If the extract of malt is prepared according to the process of the United States Pharmacopeia, the fresh preparation will contain *diastase*, an efficient ferment and capable of converting starch into dextrose. The diastatic power rapidly deteriorates on keeping. The extracts of malt are extensively used as digestants and as general tonics, but their value is more or less questionable, probably on account of the difficulty of obtaining the preparation fresh and properly prepared. Heat above 57°C. (135°F.) destroys the diastase.

DIASTASUM (Nonofficial)

(Diastase.)

Diastase is a mixture containing amylolytic enzymes obtained from an infusion of malt. It occurs as a yellowish-white, amorphous powder, or in translucent scales; odorless and tasteless. It has the power of converting not less than 50 times its weight of potato starch into soluble carbohydrates (dextrin and maltose). It should be kept in well-closed containers, protected from light, heat and moisture. Diastase is soluble in water, the solutions being more or less turbid; almost insoluble in alcohol. The drug was official in the U.S.P. IX, and is used as a digestant and general tonic. The average dose is 8 gr. (0.5 Gm.).

PAPAYOTIN (Nonofficial)

(Papain; Papoid; Caroid.)

Papain is a natural *albuminous ferment* obtained from *Carica papaya*, the papaw tree, growing in the tropics. It occurs as a grayish-white, amorphous powder, without odor or taste. It is soluble in water and glycerin, but insoluble in alcohol and ether. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action and Therapeutics.—It is claimed that papain will convert proteids into peptones, starch into maltose, and emulsify fats; and that although it will act in neutral or acid solutions, it is most active in solutions of an alkaline reaction (Stevens). Harlan introduced the drug in dental therapeutics for *digesting pulp tissue* after devitalization. He suggested making a paste with glycerin, acidulating with 1 or 2 min. of a 1:500 solution of hydrochloric acid. The pulp was devitalized in the usual way, and this paste sealed in contact with the dead tissue for one or two weeks, when the tissue was supposed to be liquefied. Clinical experience with the drug in dental, as well as in general therapeutics, proves it of doubtful value.

CATHARTICS

Cathartics have been elsewhere defined as agents which produce evacuation of the bowels. The drugs having this property are classified according to the intensity of their action and the character of the stool thus produced. Those that are mild in action and produce a nearly normal stool are called *laxatives*. Those more powerful, usually producing more copious stools, are termed *purgatives*. Those which produce a watery evacuation of the bowels are called *hydragogues*. Those which gripe, having a violent action, and in overdoses produce symptoms of acute enteritis, are termed *drastics*.

The chief laxatives are:

Cascara Sagrada.	Figs.
Tamarind.	Prunes.
Manna.	Honey.

It will be observed that some of the items in this list are foods rather than drugs. Certain other articles of diet may also be classed as laxatives, such as bran biscuits, brown bread, ginger bread, oatmeal, molasses, olive oil, raspberries, strawberries, etc.

The chief purgatives are:

Aloes.	Calomel.*
Senna.	Blue Mass.*
Castor Oil.	Sulphur.
Rhubarb.	Phenolphthalein.

The principal hydragogues are:

Magnesium Sulphate.	Sodium Phosphate.
Sodium Sulphate.	Magnesium Citrate.

Potassium and Sodium Tartrate.

The main drastics are:

Croton Oil.	Gamboge.
Colocynth.	Jalap.

Podophyllum.

An effort has been made by pharmacologists to study and determine the effect of cathartic drugs upon biliary secretion; but no definite knowledge is thus far available. Drugs like calomel and podophyllin are known to have a stimulating effect upon the cells of the liver, causing an increased secretion of bile; and, accordingly, these drugs are known as *cholagogues*.

CASCARA SAGRADA—U.S.P.

(Rhamnus Purshiana; Chittem Bark.)

Cascara sagrada is the *dried bark* of *Rhamnus Purshiana*, a small tree growing along the Pacific coast of North America. It contains a crystalline glucosid, *purshianin*, that is several times as active as the crude drug. The average dose of cascara sagrada bark is 15 gr. (1.0 Gm.). The following preparations are official:

Fluidextractum Cascara Sagrada, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Fluidextractum Cascara Sagrada Aromaticum, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Extractum Cascara Sagrada, U.S.P. *Dose*, 2–8 gr. (0.13–0.5 Gm.).

Physiologic Action and Therapeutics.—Cascara sagrada is a peculiarly efficient laxative. Its action is somewhat slow and is seldom accompanied with irritation or unpleasant symptoms. It is used exclusively as a tonic laxative, and in *habitual constipation* it is a reliable remedy. The drug possesses a distinct advantage over many cathartics in not readily losing its effect when frequently taken; in fact, in most cases the dose can be diminished gradually, and this is usually the most satisfactory way of administering the remedy. On account of the unpleasant bitter taste the aromatic fluid extract is the best preparation to use.

TAMARINDUS (Nonofficial)

(Tamarind.)

Tamarind is the *preserved pulp* of the *fruit* of *Tamarindus indica*, a large tree indigenous to Africa and cultivated in the West Indies. It is a gentle laxative about equal in power to the fig and prune. Its action is due chiefly to the potassium salts of tartaric, citric, malic, and acetic acids, of which it contains from 8–12 per cent. The average dose is 4 dr. (16.0 Gm.). It is a constituent of the formerly official confection of senna.

MANNA—U.S.P.

Manna is a *concrete saccharine exudation* from *Fraxinus Ornus*, a small native tree of Sicily and other Mediterranean islands. Its chief constituent is *mannite* (50–80 per cent.) a sweet crystalline principle, soluble in water. It acts as a mild laxative in doses of

1–2 oz. (32.0–64.0 Gm.). It is usually given in combination with other cathartics, and is a constituent of the official compound infusion of senna.

FICUS (Nonofficial)

(Fig.)

Fig is the *exudation* of *Fraxinus Ornus*, a native tree of the shores of the Levant, but cultivated in tropical countries. It contains about 62 per cent. of grape-sugar, also gum, fat, etc. It acts as a demulcent and laxative, and is a constituent of the formerly official confection of senna. Figs are chiefly used as an article of diet in *habitual constipation*.

PRUNUM (Nonofficial)

(Prune.)

Prune is the *dried fruit* of *Prunus Domestica*, the plum tree, indigenous to Western Asia, but cultivated in most temperate countries. It contains sugar, pectin, albumin, malic acid, and salts. Prunes are laxative and nutritious, and are freely used as food and sweetmeat. Stewed prunes are an excellent remedy for *constipation* in children. They are a constituent of the formerly official confection of senna.

MEL—U.S.P.

(Honey.)

(Replacing Mel Depuratum, U.S.P. IX; Clarified Honey.)

Honey is a *saccharine secretion* deposited in the honey-comb by *Apis Mellifera*, the honey-bee. It is a strong aqueous solution of several sugars (cane- and grape-sugar, levulose) with wax pollen, coloring and odorous matters, etc. Honey is often adulterated with starch and glucose. The dose is indefinite. Honey is a laxative, nutritive, and emollient. It is used chiefly as an emollient in *diseases of the throat* to relieve *dryness, pain, cough, and dysphagia*, and also a pleasant vehicle for certain nauseous drugs. Honey of rose is slightly astringent, and is used in gargles, sprays, or washes for *inflammatory* and *ulcerating conditions* of the mucous membrane of the mouth, throat, and nasal passages. The wax obtained from the honey-comb is a useful material in dental practice. The above mentioned honey of rose is official:

Mel Rosae, U.S.P. *Dose*, 1 fl. dr. (4.0 cc.).

ALOE—U.S.P.

(Aloes.)

Aloes is the inspissated *juice* obtained from the *leaves* of several species of genus *Aloe*, a familiar example of which is the American century plant. It grows abundantly in nearly all hot, dry countries. Two varieties were formerly recognized by the United States Pharmacopeia (1890): Barbadoes aloes (*Aloe barbadensis*), obtained from *Aloe vera*, and Socotrine aloes (*Aloe socotrina*), obtained from *Aloe perryi*. The chief constituent is *aloin*, also official, a neutral crystalline principle, and from which is obtained *emodin*, a glucosid to which the purgative property of the drug is doubtless due. Emodin is also found in senna and rhubarb. The average dose of aloes is 4 gr. (0.25 Gm.). The following preparations are official:

Aloninum, U.S.P. *Dose*, ¼–2 gr. (0.016–0.13 Gm.).
Tinctura Aloes, U.S.P. *Dose*, ½–2 fl. dr. (2.0–8.0 cc.).
Pilulæ Aloes, U.S.P. (contains about 2 gr.–0.13 Gm.). *Dose*, 1–5 pills.

The drug enters into other official preparations, as compound extract of colocynth, compound tincture of benzoin, compound pills of mild mercurous chlorid (compound cathartic pills) and other vegetable cathartic pills.

Physiologic Action and Therapeutics.—Aloes is a rather slowly acting but effective purgative. It will be noticed from the list of preparations that aloes is rarely used singly as a cathartic. In *simple, persistent constipation*, it may be combined advantageously with other drugs, nux vomica, ipecac, rhubarb, or podophyllum. Pills of aloes and iron, formerly official, are often given with benefit in *chlorosis* with constipation. The liquid preparations have a disagreeable taste which is difficult to mask and are rarely given. The pill is the popular form of administering the drug.

SENNA—U.S.P.

Senna is the dried *leaflets* of *Cassia Senna* and *Cassia angustifolia*, small shrubs growing, respectively, in Africa and India. It contains chiefly an active acid glucosid, *cathartin* or *cathartinic acid*, also *emodin*. The average dose is 1 dr. (4.0 Gm.). The following preparations are official:

Fluidextractum Sennæ, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).

Infusum Sennæ Compositum, U.S.P. IX (Black Draught: Senna, 6; Fennel, 2; Manna, 12; Epsom Salts, 12). *Dose*, 1–4 fl. oz. (30.0–120.0 cc.).

Confectio Sennæ, U.S.P., VIII (10 per cent., with Cassia Fistula, Tamarind, Prune, Fig, Sugar, and Coriander Oil). *Dose*, 1–2 dr. (4.0–8.0 Gm.).

Pulvis Glycyrrhizæ Compositus, U.S.P. (18 per cent. of Senna, with Licorice, Sulphur, Sugar, and Fennel Oil). *Dose*, ½–2 dr. (2.0–8.0 Gm.).

Syrupus Sennæ, U.S.P. (from Fluidextract). *Dose*, 2 fl. dr. (8.0 cc.).

Extract of senna (1.5 per cent.) is a constituent of compound syrup of sarsaparilla.

Physiologic Action and Therapeutics.—Senna acts energetically as a purgative. Its action is more irritating than that of rhubarb and more prompt and powerful than that of aloes. It is one of the best vegetable purgatives, and its effect is certain and reliable in *simple, acute constipation.* In *habitual costiveness*, compound licorice powder is a popular household remedy. It is given at bedtime in about a teaspoonful dose, governed by the age of the patient.

OLEUM RICINI—U.S.P.

(Castor Oil.)

Castor oil is a fixed oil expressed from the *seed* of *Ricinus communis*, a plant indigenous to India, but cultivated in many other temperate countries. It occurs as a pale yellow, viscid oil, having a faint odor and a slightly acrid, offensive taste. It is freely soluble in alcohol. It contains the glycerid of ricinoleic acid, called *ricinolein*, and to which the purgative property of the drug is due. The dose of castor oil is from 1 fl. dr.–1 fl. oz. (4.0–30.0 cc.), governed by the age of the patient.

Physiologic Action and Therapeutics.—Castor oil is a mild, but thorough purgative. Stevens[1] states that while its fate in the body has not been definitely determined, it is probable that it escapes from the stomach unchanged, and that in the presence of the alkaline juices of the intestines saponification occurs with the liberation of ricinoleic acid, which is subsequently converted into ricinoleates. The latter induce catharsis by stimulating the muscular coat of the bowel, and are probably absorbed in part, since the oil is known to impart its purgative properties to the milk when given to nursing women; but some oil may be seen floating in the stools.

[1] Modern Materia Medica and Therapeutics.

Castor oil has long been a household remedy to remove irritant material from the bowel in the beginning of *acute inflammatory diarrhea*, especially in children. It is not a suitable remedy for habitual constipation, as is generally supposed by the laity. The drug is a desirable constituent of many lotions, used on the scalp for *dandruff*, etc., owing to its solubility in alcohol.

Patrick, Moyer, and other neurologists highly recommend large doses of castor oil in *tic douloureux*. Smaller doses are first administered, and gradually increased until large quantities may be taken daily without inducing catharsis.

The main objection to castor oil as a therapeutic agent is its disagreeable taste. Many substances have been suggested to overcome this objection, among which may be mentioned the oils of peppermint, gaultheria, and cinnamon. A pleasant combination follows:

> Castor Oil, 8 oz. (240.0 cc.); Oil of Peppermint, 5 min. (0.3 cc.); Saccharin, 2 gr. (0.13 Gm.); and Alcohol, 1 dr. (4.0 cc.). The Oil of Peppermint and Saccharin should first be dissolved in Alcohol and then added to the Castor Oil. The usual dose may be given.

Castor oil may also be given in the socalled "castor oil sandwich." Place fruit juice in the bottom of the glass, next add the oil, and then a teaspoonful of brandy, moistening the lip of the glass with the latter. This may be taken at once without detecting the taste of the castor oil. Flexible capsules, when they can be swallowed, afford an excellent means of giving the remedy.

RHEUM—U.S.P.

(Rhubarb.)

Rhubarb is the *root* of *Rheum officinale*, a perennial herb resembling garden rhubarb, but of larger growth, and a native of China, Thibet, and other Asiatic countries. It contains *chrysophanic acid*, *emodin*, *tannic acid*, and several resinous principles. It is to emodin and possibly some of the resinous principles that rhubarb owes its purgative properties, for chrysophanic acid has no purgative action and tannic acid is an astringent. The average dose of rhubarb is 15 gr. (1.0 Gm.). The following preparations are official:

> Tinctura Rhei, U.S.P. (10 per cent., with Cardamom). *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
> Tinctura Rhei Aromatica, U.S.P. (20 per cent., with Aromatics). *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).

Fluidextractum Rhei, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Extractum Rhei, U.S.P. *Dose*, 5–10 gr. (0.3–0.6 Gm.).
Syrupus Rhei, U.S.P. (10 per cent. of the fluid extract). *Dose*, 1–6 fl. dr. (4.0–22.5 cc.).
Syrupus Rhei Aromaticus, U.S.P. (15 per cent. of aromatic tincture and spiced syrup of Rhubarb). *Dose*, 1–6 fl. dr. (4.0–22.5 cc.).
Pulvis Rhei Compositus, U.S.P. (Gregory's Powder; Rhubarb, 25; Magnesia, 65; Ginger, 10). *Dose*, 20–60 gr. (1.3–4.0 Gm.).

Physiologic Action and Therapeutics.—Rhubarb acts, in appropriate doses, as a purgative and stomachic. As a secondary effect, however, it frequently causes constipation, due to the tannic acid it contains. Doses of from 1–3 gr. (0.06–0.2 Gm.) often produce no cathartic action, but its effect upon the stomach is that of a mild astringent and tonic.

As an agent for removing irritant material from the bowel in the beginning of *acute inflammatory diarrhea*, especially in children, rhubarb is highly efficient. To check *diarrhea in cholera morbus* the following has been a popular remedy: tincture of rhubarb, tincture of capsicum, tincture of opium, spirit of camphor, and spirit of peppermint—an equal quantity of each. The dose is from 15–30 min. (1.0–2.0 cc.), in water.

SULPHUR

(S.)

The element **sulphur** is recognized by the United States Pharmacopeia in three forms:

Sulphur Sublimatum.—U.S.P. (Sublimed Sulphur; Flowers of Sulphur).—This occurs as a fine yellow powder, having a slightly characteristic odor and a faintly acid taste. It is insoluble in water, partially soluble in absolute alcohol, ether, and chloroform. The average dose is 1 dr. (4.0 Gm.). It enters into one official preparation:

Unguentum Sulphuris, U.S.P. (15 per cent.).

Sulphur Lotum—U.S.P. (Washed Sulphur).—This form of sulphur is prepared by digesting sublimed sulphur for three days in weak ammonia water, and then washing. It enters into one official preparation:

Pulvis Glycyrrhizæ Compositus, U.S.P. (8 per cent.) Also, Unguentum Sulphuris Compositum, N.F.

Sulphur Præcipitatum—U.S.P. (Precipitated Sulphur; Milk of Sulphur).—This is a fine, almost white powder, without odor or taste. It is prepared by precipitation from calcium sulphid solutions with diluted hydrochloric acid. The average dose is 1 dr. (4.0 Gm.).

Physiologic Action and Therapeutics.—Sulphur acts locally as a stimulant and parasiticide. Internally, it acts as a mild purgative. As a stimulating remedy it has been recommended in *periodontoclasia*, but its use is of doubtful value. It is a reliable remedy, however, in parasitic diseases, like *scabies* (itch) and *ringworm*. The ointment may be employed. The drug may be given internally, mixed with honey or molasses, as a laxative. When sulphur is burned in the air, sulphur dioxid (SO_2) is formed. This acid-forming oxid (anhydrid) unites with water to form sulphurous acid (H_2SO_3), which latter product is a potent disinfectant and bleaching agent. Kirk recommends a mixture of boric acid and sodium sulphite as a bleaching agent for tooth-structure. The mixture should be placed in the cavity dry, then moistened and hermetically sealed. A reaction is brought about whereby sulphurous acid is formed.

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PHENOLPHTHALEINUM—U.S.P.

(Phenolphthalein; $C_{20}H_{14}O_4$.)

Phenolphthalein is a dibasic phenol derivative. It occurs as a white or faintly yellowish-white, crystalline powder; without odor or taste; permanent in the air. Almost insoluble in water; soluble in 13 parts of alcohol, and in 70 parts of ether at 25°C. It is dissolved by solutions of the alkali hydroxids and carbonates with a *red color*. The solutions are *decolorized* by the addition of acids in excess. Owing to this peculiar property the agent is used as an *indicator* in volumetric assaying and in quantitative analysis. The drug has been recommended as a purgative. The average dose is 1 gr. (0.06 Gm.).

MAGNESII SULPHAS—U.S.P.

(Magnesium Sulphate; Epsom Salt; $MgSO_4.7H_2O$.)

Magnesium sulphate occurs in small, colorless, rhombic prisms or acicular crystals, without odor, and having a cooling, saline, unpleasant, and bitter taste; soluble in 1.5 parts of water, and insoluble in alcohol. The average dose is 4 dr. (16.0 Gm.). The drug enters into one preparation which was formerly official:

Infusum Sennæ Compositum, U.S.P. IX. *Dose*, 4–6 fl. oz. (120.0–180.0 cc.).

Magnesii Sulphas Effervescens, U.S.P. VIII (contains Magnesium Sulphate, 500; Sodium Bicarbonate, 403; Tartaric Acid, 211; Citric Acid, 136). *Dose*, 1–8 dr. (4.0–32.0 Gm.).

Physiologic Action.—Magnesium sulphate is a typical representative of the class of saline cathartics, all of which produce evacuation of the bowels chiefly by increasing the amount of fluid in the intestine. They differ in their action from vegetable cathartics in that they stimulate peristalsis but feebly. They not only hinder the absorption of fluid taken with the food, but they abstract more fluid directly from the tissues and blood. To understand thoroughly this so-called *salt action*—*i.e.*, the behavior of saline solutions of varying degrees of concentration in relation to the salinity of the blood serum, by which a flow of fluid to or from the blood is determined—it is necessary that we be familiar with certain physical processes, chief among which is that of *osmosis*—the passage of salts through animal membranes, or the force by which fluids are impelled through organic membranes. If, for example, a 10 per cent. solution of common salt is placed in the bottom of a container and water placed in the top, the two liquids being separated by a more or less permeable animal membrane, in a few moments it will be observed that the specific gravity of the two fluids is the same. By the process of osmosis, then, the salt from the solution in the bottom has passed through the membrane, and a 5 per cent. solution of common salt on both sides of the separating medium is the result. A *semipermeable membrane* is one which allows the passage of one sort of molecules (usually the solvent), while impervious to another (usually the dissolved substance). The interposition of such a membrane between salt solutions of varying degrees of concentration introduces very important modifications in the osmotic process, and results in the development of what is termed *osmotic pressure*. The walls of the intestines are only partly semipermeable; *i.e.*, they are partly permeable to salts, though much less readily than to water. If two solutions having the same molecular concentration in dissolved substance (*i.e.*, *equimolecular*) are separated by a semipermeable membrane impermeable to the dissolved substance, it is evident that no change of liquid will occur. Such solutions, having the same specific gravity and, therefore, the same osmotic tension or pressure, are called *isotonic* to each other. In physiologic literature "isotonic" usually means solutions having the same concentration (specific gravity) as blood-serum, and it is in this sense that the term is used in these pages. If one solution has a greater concentration than the other and the separating medium be a partly semipermeable membrane, like the

walls of the intestines, water principally will pass from the weaker into the stronger solution until both are of the same concentration. The stronger solution is then called *hyperisotonic;* the weaker, *hypoisotonic.* Neither being isotonic, they are called *anisotonic.*

With this knowledge of salt action we can readily understand how saline cathartics, in normal subjects, act as hydragogues, *i.e.*, produce a watery evacuation of the bowels, and why they are absorbed from the intestine very slowly and in but small quantities, the greater portion escaping from the body in the stools. The action of saline cathartics, therefore, is purely local, which fact is sustained by the further fact that they do not produce catharsis when intravenously injected. When saline cathartics are administered to an anhydremic patient (having a deficient amount of water in the blood) the process of their action is reversed; instead of the blood in the adjacent tissues yielding its water to the intestine, the blood abstracts water from the bowel, the greater portion of the salt is absorbed, and purgation does not ensue. This means that a hypoisotonic solution of the salt must necessarily be administered, otherwise this result would not follow. An isotonic or perhaps a hyperisotonic solution with a normal subject might be hypoisotonic in cases of anhydremia.

Magnesium sulphate in concentrated solution (hyperisotonic), is an active hydragogue cathartic, producing in a few hours a copious watery evacuation of the bowel without much pain or systemic disturbance. Dilute solutions (hypoisotonic) do not produce purgation, but, the salt being absorbed in greater quantity, they act as diuretics, increasing the flow of urine.

Therapeutics.—Magnesium sulphate, being practically free from irritant properties, is an excellent cathartic for removing undigested material from the bowel in *acute enteritis* and *colitis* (colic). Stevens speaks favorably of saline cathartics in *chronic constipation*, giving a small dose before breakfast, claiming that they are sometimes more efficacious than vegetable cathartics. While vegetable cathartics are usually given at night on account of their rather slow action, generally causing no inconvenience until morning, saline cathartics act more promptly and powerfully when given before breakfast.

Saline cathartics are especially indicated in *acute alveolar abscess* as they deplete the engorged tissues, preventing stagnation of the blood in the affected part, thus aiding nature materially in preventing the infected tissues from being broken down into pus. A heaping teaspoonful of Epsom salt may be dissolved in a wineglass half full of warm water, having at hand, in another glass, some fresh

water. By drinking the fresh water as soon as the concentrated solution is taken, the bitter taste of the drug will scarcely be noticed.

Epsom salt is also used in *phenol poisoning*, and in *acute lead poisoning*. With phenol, the innocuous phenol sulphonate is formed, and with the soluble salts of lead (acetate) an insoluble sulphate.

Incompatibles.—Magnesium sulphate is incompatible with lead acetate (sugar of lead), silver nitrate, alkaline carbonates, and lime-water.

SODII SULPHAS—U.S.P.

(Sodium Sulphate; Glauber's Salt; $Na_2SO_4.10H_2O$.)

Sodium sulphate occurs in large, colorless, transparent prisms or granular crystals, odorless, and having a bitter, saline taste. It is soluble in 1.2 parts of water, and insoluble in alcohol. The average dose is 4 dr. (16.0 Gm.).

Physiologic Action and Therapeutics.—Sodium sulphate acts as a powerful hydragogue cathartic, producing large watery stools. Its action is accompanied by considerable griping, because of which Epsom salt has largely superseded the drug. Sodium sulphate enters into the mixture known as artificial Carlsbad salt, which, given in doses of a teaspoonful in a glassful of hot water half an hour before breakfast, makes an efficient mild aperient. The formula follows: sodium sulphate, 5 oz. (160.0 Gm.); sodium bicarbonate, 2 oz. (64.0 Gm.); sodium chlorid, 1 oz. (32.0 Gm.). Both sodium and magnesium sulphates are active ingredients in certain natural mineral waters, like Hunyadi Janos, Carlsbad, etc. These waters may be given in cases of *periodontoclasia* associated with *rheumatism* or *gout*.

SODII PHOSPHAS—U.S.P.

(Sodium Phosphate; $Na_2HPO_4.12H_2O$.)

Sodium phosphate occurs in large, colorless, prismatic crystals, without odor, but having a cooling, saline taste. It is soluble in 2.7 parts of water, and insoluble in alcohol. The dose is from 1 gr.–4 dr. (0.06–16.0 Gm.), depending on the age of the patient. For a young child a small amount only is necessary. The following preparations are official:

Sodii Phosphas Effervescens, U.S.P. *Dose*, 1–8 dr. (4.0–32.0 Gm.).

Sodii Phosphas Exsiccatus, U.S.P. *Dose*, 10–60 gr. (0.6–4.0 Gm.).

Physiologic Action and Therapeutics.—The manner of action of sodium phosphate depends upon the quantity administered. In small doses it acts as a laxative; in large doses, as a purgative. Its mild action and agreeable taste especially commend it for children, to whom the proper doses may be given in milk or other liquid food. The drug is a true cholagogue. It may be given in small doses in hot water before breakfast, in *chronic gastric catarrh with constipation*, also in *simple catarrhal jaundice*.

MAGNESII CITRAS (Nonofficial)

(Magnesium Citrate; $Mg_3(C_6H_5O_7)_2.14H_2O$.)

Magnesium citrate is obtained by dissolving magnesium carbonate in citric acid. It is a colorless substance, easily soluble in water. It is only official in the form of solution of magnesium citrate, which is compounded in a specially prepared 12 fl. oz. (360.0 cc.) bottle.

> Liquor Magnesii Citratis, U.S.P. *Dose*, 6–12 fl. oz. (180.0–360.0 cc.).

In cases of *acute alveolar abscess* where it is desired to administer a saline cathartic, this solution is highly efficacious. It is well tolerated by the stomach, and its action is effective. It is somewhat irritating, and should not be administered when there is any inflammation of the gastrointestinal tract. An effervescent salt of magnesium citrate may be obtained from the pharmacies. Other effervescent salts are also obtainable and they are of value given the next morning after administering calomel.

POTASSII ET SODII TARTRAS—U.S.P.

(Potassium and Sodium Tartrate; Rochelle Salt; $KNaC_4H_4O_6.4H_2O$.)

Rochelle salt occurs in colorless, transparent, prismatic crystals, or as a white powder, without odor, but having a cooling, saline taste; soluble in about 1 part of water. The average dose is 2½ dr. (10.0 Gm.). It is an essential constituent of the official compound effervescent powder.

> Pulvis Effervescens Compositus, U.S.P. (Seidlitz Powder). *Dose*, 1 powder.
> A dose of Seidlitz powder is contained in two different colored papers—one blue, the other white. The *blue paper* contains Potassium and Sodium Tartrate, 120 gr. (8.0 Gm.); and Sodium Bicarbonate, 40 gr. (2.6 Gm.). The *white paper*

contains Tartaric Acid, 35 gr. (2.3 Gm.). The contents of each paper should be dissolved separately, the two solutions mixed, and the whole taken while effervescence is taking place.

Physiologic Action and Therapeutics.—Rochelle salt may be given as a hydragogue cathartic in the same conditions for which magnesium sulphate was recommended. Its administration is more agreeable than the latter, but its action is less active. The carbonic acid evolved during the effervescence of a Seidlitz powder exerts a more or less sedative influence on the stomach, as well as making the solution more palatable. As a mild saline cathartic, especially during the summer season, a dose of Seidlitz powder is highly efficacious.

OLEUM TIGLII—U.S.P.

(Croton Oil.)

Croton oil is a fixed oil expressed from the *seeds* of *Croton Tiglium*, a small native tree of China, but extensively cultivated in India and the Philippine Islands. It occurs as a yellowish, viscid oil, having a faint odor and an acrid, burning taste. It contains *croton-oleic acid*, both free and as a glycerid, together with several other inactive fatty acids. The average dose of croton oil is 1 min. (0.05 cc.).

Physiologic Action and Therapeutics.—Croton oil is a violent irritant. When applied, undiluted, to the skin it causes redness and burning, followed by a copious eruption of pustules. Therefore it must be handled with caution. When internally administered it acts as a powerful drastic cathartic, causing in one or two hours several copious movements of the bowels, attended with considerable pain, and sometimes with nausea. Large doses produce all the symptoms of a severe gastroenteritis—burning sensation in the stomach, pain, etc. On account of the ease with which it may be administered (small quantities being so effectual) the drug is a convenient cathartic to give in cases where the patient can swallow only with difficulty. It may be taken in a small amount of olive oil or glycerin or in a pill with bread-crumbs as an excipient. The prompt irritant action of croton oil on the bowel makes it a useful revulsant in cases of cerebral congestion; therefore, its effect is advantageous in *uremia*, *apoplexy*, and *acute mania*. In cases like *lead poisoning*, where *obstinate constipation* is a concomitant, the drug is especially useful.

Croton oil may be mixed with some indifferent oil (croton oil, 1 part; olive oil, 7 parts) and used as a dental counterirritant. It has no advantage here, however, over the more generally used coun-

terirritants (iodin, mustard, capsicum, etc.). Stevens speaks favorably of a mixture of croton oil (1 part) and tincture of iodin (2 parts) to be used as a pigment in *neuritis*.

COLYCYNTHIS—U.S.P.

(Colycynth.)

Colycynth is the *dried pulp* of the unripe but fully grown *fruit* of *Citrullus Colocynthis* deprived of its rind. The plant grows in arid places in Asia, Africa, and Southern Europe. It contains *colocynthin*, a bitter glucosid, to which its cathartic property is largely due. The average dose of colocynth is 1 gr. (0.06 Gm.). The following preparations are official:

Extractum Colocynthidis, U.S.P. *Dose*, 2–5 gr. (0.13–0.3 Gm.).
Extractum Colocynthidis Compositum, U.S.P. *Dose*, 5–20 gr. (0.3–1.3 Gm.).
Pilulæ Hydrargyri Chloridi Mite Compositæ, U.S.P. *Dose*, 1–3 pills.
Pilulæ Catharticæ Vegetabiles, U.S.P., VIII. *Dose*, 1–3 pills.

Physiologic Action and Therapeutics.—Colocynth is an energetic drastic cathartic, producing in full doses copious, watery stools, accompanied frequently by griping. In large doses the irritation excites inflammation of the whole alimentary tract, which may prove fatal. The drug is too irritant to be used alone, and is only given in combination with other drugs in cases of *obstinate chronic constipation*, which frequently accompanies old age.

CAMBOGIA—U.S.P.

(Gamboge.)

Gamboge is a *gum-resin* obtained from *Garcinia Hanburii*, a laurel-like tree growing in the East Indies. Its active principle is *cambogic acid*. The average dose of the drug is 2 gr. (0.13 Gm.). It enters into the following official preparation:

Pilulæ Hydrargyri Chloridi Mite Compositæ, U.S.P. *Dose*, 1–3 pills.

Physiologic Action and Therapeutics.—Gamboge is an active drastic cathartic. In large doses its irritant effect is capable of causing fatal gastroenteritis. It is never used alone, but may be combined with less powerful cathartics and used in *obstinate chronic constipation*.

JALAPA—U.S.P.

(Jalap.)

Jalap is the *tuberous root* of *Exogonium Jalapa*, a perennial herb growing in Mexico. It contains two resins, *jalapin* and *convolvulin*, both of which are active. The average dose of jalap is 15 gr. (1.0 Gm.).

Its official preparations follow:

Resina Jalapæ, U.S.P. *Dose*, 1–5 gr. (0.06–0.3 Gm.).

Pulvis Jalapæ Compositus, U.S.P. (contains Jalap, 35; Potassium Bitartrate, 65). *Dose*, 15–60 gr. (1.0–4.0 Gm.).

Pilulæ Hydrargyri Chloridi Mite Compositæ, U.S.P. *Dose*, 1–3 pills.

Pilulæ Catharticæ Vegetabiles, U.S.P. VIII (each pill contains extract of Jalap, ½ gr.–0.03 Gm.; compound extract of Colocynth, about 1 gr.–0.06 Gm.; extract of Hyoscyamus, ½ gr.–0.03 Gm.; extract of Leptandra, ¼ gr.–0.015 Gm.; extract of Podophyllum, ¼ gr.–0.015 Gm.; and Oil of Peppermint). *Dose*, 1–3 pills.

Physiologic Action and Therapeutics.—The action of jalap is more like that of the hydragogue cathartics than it is of the drastic. It acts gently, producing, within three or four hours, copious, watery stools. Pharmacologists (Stadelmann, and others) claim that the drug has no action in the absence of bile, the latter serving in all probability as a solvent. For removing the water from the tissues in *dropsy* the drug is frequently combined with a saline, as in the official compound powder of jalap. It is not employed alone as a cathartic, but it is an ingredient of both the official compound cathartic pills and formerly official compound vegetable pills, which preparations are frequently given in *habitual constipation*.

PODOPHYLLUM—U.S.P.

(May Apple; Mandrake.)

Podophyllum is the *rhizome* and *rootlets* of *Podophyllum peltatum*, a perennial herb, growing in the moist woods of Canada and northern United States. It contains two isomeric glucosids, *podophyllotoxin* and *picropodophyllin*, and also a resin, *podophyllin*, which is official. The average dose of podophyllum is 5 gr. (0.3 Gm.). The only official preparation is:

Resina Podophylli, U.S.P. *Dose*, ⅛–½ gr. (0.008–0.03 Gm.).

The resin is also a constituent of compound cathartic pills.

Physiologic Action and Therapeutics.—Podophyllum is an active drastic cathartic. Its action is rather slow, however, com-

pared with most other drastics; it generally requires from ten to twelve hours to produce an evacuation of the bowel. The stools are copious and watery, and usually attended with more or less griping pain. The drug is used in *habitual constipation*, associated with so-called *biliousness*. It is a direct and strong cholagogue. When combined with other cathartic drugs, those should be selected which are also slow in action, like aloes, calomel, etc. The resin is the most reliable preparation and is generally given in the form of pills. Combined with belladonna the griping effect of the drug is largely overcome.

DIURETICS

Diuretics are agents that increase the flow of urine. They may act indirectly by forcing a greater volume of blood through the kidneys, or directly by stimulating the renal epithelium. A number of them act in both ways. Certain circulatory stimulants also act as diuretics, among which may be mentioned digitalis and caffein. Digitalis appears to have no special action on the secreting cells of the kidneys; its effect as a diuretic is almost entirely dependent upon the influence the drug has over the cardiovascular system. Caffein, on the other hand, is a powerful diuretic, acting directly on the renal epithelium, and, in a lesser degree, on the circulation.

The inorganic salts, urea, and other soluble proteids, normally present in the blood, may be regarded as the physiologic stimuli of the secreting cells of the kidneys. Many other substances, not natural components of the blood, increase the secretion of urine by exerting a direct and specific influence on the cells of the glomeruli and convoluted tubes (Stevens).

Diuretics are employed in dental practice principally for the purpose of removing from the blood certain excrementitious matters, which are supposed to be forerunners of periodontoclasia. The agents used are chiefly the vegetable salts of potassium and lithium, which not only increase the amount of urine excreted, but, being eliminated through the kidney in large part as carbonates, they tend to make the urine alkaline in reaction. Examples of diuretics follow:

Potassium Bicarbonate.	Potassium Chlorate.
Potassium Carbonate.	Potassium Nitrate.
Potassium Citrate.	Lithium Carbonate.
Potassium Acetate.	Lithium Citrate.
Potassium Bitartrate.	Lithium Benzoate.
Caffein.	Theobromin.

POTASSII BICARBONAS—U.S.P.

(Potassium Bicarbonate; $KHCO_3$.)

Potassium bicarbonate occurs in colorless prismatic crystals, without odor, but having an unpleasant, saline, alkaline taste; soluble in 3 parts of water, and practically insoluble in alcohol. The average dose is 15 gr. (1.0 Gm.). Potassium bicarbonate, though not contained therein as such, is used in making the following official solutions:

Liquor Magnesii Citratis, U.S.P. *Dose,* 12 fl. oz. (350.0 cc.).
Liquor Potassii Arsenitis, U.S.P. (Fowler's Solution). *Dose,* 3 min. (0.2 cc.).
Liquor Potassii Citratis, U.S.P. *Dose,* 4 fl. dr. (15.0 cc.).

POTASSII CARBONAS—U.S.P.

(Potassium Carbonate; K_2CO_3.)

Potassium carbonate occurs in a white, granular, deliquescent powder; freely soluble in water, but insoluble in alcohol. The average dose is 15 gr. (1.0 Gm.). The drug is very irritant and rarely used as such internally; from potassium carbonate, however, the following official preparation is made:

Pilulæ Ferri Carbonatis, U.S.P. (Blaud's Pills). *Dose,* 2 pills.

POTASSII CITRAS—U.S.P.

(Potassium Citrate; $K_3C_6H_5O_7.H_2O$.)

Potassium citrate occurs in transparent, prismatic crystals or white, granular, deliquescent powder, without odor, but having a pleasant saline taste; soluble in 0.5 part of water, but sparingly soluble in alcohol. The average dose is 1 dr. (4.0 Gm.). There are two official preparations. They are:

Liquor Potassii Citratis, U.S.P. *Dose,* ½–1 fl. oz. (15.0–30.0 cc.).
Potassii Citras Effervescens, U.S.P. *Dose,* 30–90 gr. (2.0–6.0 Gm).

POTASSII BITARTRAS—U.S.P.

(Potassium Bitartrate; Cream of Tartar; $KHC_4H_4O_6$.)

Cream of Tartar occurs in colorless, or slightly opaque, rhombic crystals, or as a white powder, without odor, but having an acidulous taste; soluble in about 155 parts of water, and very sparingly

soluble in alcohol. The average dose is 15 gr. (1.0 Gm.). It is a component of the following official preparation:

Pulvis Jalapæ Compositus, U.S.P. *Dose*, 15–60 gr. (1.0–4.0 Gm.).

POTASSII ACETAS—U.S.P.

(Potassium Acetate; $KC_2H_3O_2$.)

Potassium acetate occurs in the form of a white powder or crystalline masses, very deliquescent, odorless, and having a pleasant, saline taste; soluble in 0.4 part of water and in 2 parts of alcohol. The average dose is 15 gr. (1.0 Gm.).

Physiologic Action.—The vegetable salts of potassium act similarly and will, therefore, be discussed here conjointly. The potassium ion is much more physiologically active than is the sodium ion, and as a result the potassium salts, as a rule, are more irritant and depressant than are the corresponding sodium salts. With the vegetable salts of potassium, however, the action of the base is entirely subordinate to that of the acid radical, and a depressant effect is never observed except when administered continuously or in enormous doses. The dominant action of any one of the vegetable salts of potassium is upon the secreting cells of the kidneys, increasing the amount of urine. The mineral salts of the urine, both of potassium and sodium, are increased, but the evidence is not convincing that the vegetable salts of potassium materially assist oxidation in the tissues, and in consequence augment nitrogenous elimination. In large doses they do, however, impart an alkaline reaction to the urine, and in hyperisotonic solution they act as saline cathartics, producing free watery discharges. Potassium bitartrate differs somewhat from the other vegetable salts of this metal in that it resists oxidation in the body, and, therefore, much of it is eliminated unchanged. It is also a more active cathartic.

Therapeutics.—Clinical experience has fully demonstrated that *acute rheumatism* is influenced favorably by the administration of the vegetable salts of potassium; and it is also true that *periodontoclasia* in rheumatic or gouty subjects is favorably influenced by these salts, but until we have a clearer understanding of the nature of these diseases, it is useless to speculate upon the mode of action of the remedies employed in their treatment. In these cases 10–30 gr. (0.6–2.0 Gm.) of the salt may be dissolved in water and administered. The dose should be repeated every three or four hours until the urine becomes neutral or slightly alkaline. Both the official

solution of potassium citrate and the effervescent salt are agreeable preparations to take. Stevens[1] speaks favorably of combining an alkaline salt with a salicylic compound. Salophen may be selected for this purpose, for while it is practically insoluble in water, it is freely soluble in watery solutions of the alkaline salts.

The vegetable salts of potassium are efficient sedative expectorants in the beginning of *acute bronchitis*, especially when the secretion is viscid and scanty.

Incompatibles.—The vegetable salts of potassium are incompatible with acids, mineral salts, and alkaloidal salts.

POTASSII CHLORAS—U.S.P.

(Potassium Chlorate; $KClO_3$.)

Potassium chlorate occurs in colorless, crystalline plates, without odor, but having a cooling saline taste; soluble in 11.5 parts of water, sparingly soluble in alcohol but is soluble in glycerin. The average dose is 4 gr. (0.25 Gm.). There was formerly one official preparation:

> Trochisci Potassii Chloratis, U.S.P. IX (each contains about 2½ gr.–0.15 Gm.). *Dose*, 1–5 troches.

Physiologic Action.—Potassium chlorate, when applied in dilute form to the mucous membrane, acts as a stimulating alterative; in concentrated form it is a decided irritant. The exact manner of its action is not fully understood. It was supposed formerly that the drug, when internally administered, yielded its oxygen to the blood, but recent investigation tends to prove that this theory is erroneous and that fully 90 per cent. passes out of the body unchanged in the urine, though small quantities have been detected in the saliva, tears, and milk of nursing women. In moderate doses, well diluted, its only noticeable effect is to increase the flow of urine. It does not alkalize the urine as do most of the potassium salts.

Poisoning and Treatment.—In excessively large doses potassium chlorate produces toxic symptoms. Its basic radical or potassium ion depresses the circulation and nervous system, while its acid radical or chlorate ion irritates the stomach, intestines, and kidneys. In the *treatment of poisoning* the stomach should be evacuated by emetics or the stomach-pump, followed, as usual, with demulcents. In case of exhaustion, physiologic salt solution may be subcutaneously injected.

[1] Modern Materia Medica and Therapeutics.

Therapeutics.—In all inflammatory conditions of the mouth and throat, potassium chlorate makes an excellent local application. Ten grains (0.6 Gm.) to the ounce (30.0 cc.) may be used as a wash, gargle, or spray. In *mercurial stomatitis*, the salt is almost a specific, and may be employed internally as well as locally. It is quite generally believed by medical men that *salivation* is less likely to follow the continuous use of mercury in *secondary syphilis* when a solution of potassium chlorate is simultaneously used as a mouth-wash. Cushney[1] states that the drug may be given internally as a prophylactic to prevent stomatitis when mercury is being prescribed, but that it does not prevent the salivation. Oral prophylaxis and mouth hygiene are considered important factors in the treatment of syphilis to-day.

The drug is used as a constituent of dental pastes which have gained some prominence as a cure for many mouth diseases. The amount of potassium chlorate in these pastes ranges from 10 to 50 per cent., and in this strength they should not be applied to the mucous membrane of the mouth, as harm is likely to follow. Where the drug is indicated, it is far better to confine its use to weak solutions.

Incompatibles.—Potassium chlorate, being rich in oxygen which it readily gives up, makes the drug incompatible with many easily oxidizable substances, like sulphur, phosphorus, pulverized charcoal, tannic acid, sugar, sulphids, hyposulphites, hypophosphites, and ammonium chlorid.

POTASSII NITRAS—U.S.P.

(Potassium Nitrate; Saltpeter; KNO_3.)

Potassium nitrate occurs in colorless, transparent, rhombic prisms or as a crystalline powder, odorless, and having a cooling saline taste; soluble in 3.6 parts of water, sparingly soluble in alcohol. The average dose is 8 gr. (0.5 Gm.) in solution, well diluted.

Physiologic Action and Therapeutics.—Except that it is more irritating to the stomach, the action of potassium nitrate in moderate doses does not differ materially from the vegetable salts of potassium; it increases the secretion of urine through direct action on the renal epithelium. In large doses potassium nitrate is not only more irritating than the vegetable salts, but is markedly more depressant to the heart and nervous system; for here the action of the base (potassium) is not subordinate to that of the acid radical. Toxic

[1] Pharmacology and Therapeutics, or the Action of Drugs.

doses produce the symptoms of gastroenteritis, muscular weakness, and collapse.

Potassium nitrate is not used in dental therapeutics. It has been employed in *general dropsy*, but it has no greater efficacy than the less irritating vegetable salts. Inhalations of the smoke of burning niter paper, formerly official, sometimes afford relief in *asthma*. Solutions of the drug, called "brine," are useful for preserving meats. A mixture of equal parts of potassium nitrate and borax makes a most excellent reducing agent for refining gold scrap. The latter should be placed on charcoal and fused, when the "oxidizing mixture" is added. The potassium nitrate will oxidize the base metals which oxids are dissolved by the borax and absorbed by the charcoal, leaving the gold practically pure.

LITHII CARBONAS (Nonofficial)

(Lithium Carbonate; Li_2CO_3.)

Lithium carbonate occurs as a white powder, without odor, but having an alkaline taste; soluble in 75 parts of water and insoluble in alcohol. The average dose is 8 gr. (0.5 Gm.).

LITHII CITRAS (Nonofficial)

(Lithium Citrate; $Li_3C_6H_5O_7.4H_2O$.)

Lithium citrate occurs as a white, deliquescent powder, without odor, but having a cooling saline taste; soluble in 2 parts of water, insoluble in alcohol. The average dose is 8 gr. (0.5 Gm.).

Physiologic Action and Therapeutics.—The action of the vegetable salts of lithium is very similar to that of the corresponding salts of potassium, because the action of the base in both groups is entirely subordinate to that of the acid radical. They increase the quantity of urine and lessen its acidity.

The salts of lithium have been recommended in the past in the treatment of *gout* and the *uric acid diathesis* because it was found that outside of the body lithium united with uric acid to form a more soluble salt than did either potassium or sodium, but since it has been clearly demonstrated that alkaline medication is without influence on the uratic salts present in the blood or tissues, it is doubtful whether the salts of lithium are any more potent in these diseases than are the vegetable salts of potassium (Stevens). On the hypothesis that the concretions in *periodontoclasia* were precipitated and deposited on the roots of teeth as the blood, supercharged with suboxidized or

excrementitious material, slowly passed through the pericemental membrane, lithium salts and the natural mineral waters have been extensively employed in the treatment of this condition. But, as above mentioned, since it is clearly proven that lithium salts are without influence on the urates in the blood or tissues, and since, too, it has never been clearly demonstrated that the deposits are formed from the source mentioned, it is indeed doubtful whether these salts play any rôle in the eradication of the disease, except to increase the amount of urine. In the case of the natural waters, the efficacy which they may possess in this disease is probably dependent upon the depurant (purifying) action of the water itself, and not upon the small amount of salt they contain. On this basis, the drinking of large quantities of pure, wholesome water in the treatment of this disease is recommended.

DIAPHORETICS

Diaphoretics are agents which promote the secretion of perspiration. When the action of the remedy is such that the sweat stands in beads upon the surface, it is called a *sudorific*.

The agents employed may act directly by stimulating the special nerve fibers supplying the sweat glands, indirectly by stimulating the sweat centers of the central nervous system from which those fibers originate, or reflexly by irritating peripheral sensory nerves. The activity of the sweat glands is increased by dilatation of the peripheral vessels, external heat, muscular exercise, dyspnea, strong emotion, nausea, and various drugs (Stevens). Diaphoretics are chiefly used for their evacuant, revulsive, and alterative effects, and also to promote absorption. The drugs usually employed for promoting perspiration are:

Pilocarpus.	Liquor Ammonium Acetate.
Spirit of Nitrous Ether.	Opium.*

PILOCARPUS (Nonofficial)

(Jaborandi.)

Pilocarpus is the *leaflets* of *Pilocarpus Jaborandi* and *Pilocarpus microphyllus*, shrubs growing in South America. It contains three alkaloids—*pilocarpin*, *pilocarpidin*, and *isopilocarpin*—all of which are physiologically active, but pilocarpin is the most active, is present in greater quantity, and yields with acids soluble crystalline salts, of which two are official: *Pilocarpinæ Nitras*, *U.S.P.*, and

Pilocarpinæ Hydrochloridum, U.S.P. These salts are most commonly used; the average dose of either is by mouth, 1/6 gr. (0.01 Gm.); hypodermic, 1/12 gr. (0.005 Gm.). The average dose of pilocarpus is 30 gr. (2.0 Gm.). Both the drug and the fluid extract were official in the U.S.P. IX:

> Fluidextractum Pilocarpi, U.S.P. IX. *Dose*, 10–60 min. (0.6–4.0 cc.).

Physiologic Action and Therapeutics.—Probably no other single drug exerts the same influence on the secretory glands of the body as pilocarpin. When internally administered, even in small doses, the sweat and saliva are markedly increased. It also increases, but to a lesser degree, the lacrymal, nasal, bronchial, gastric, intestinal, and renal secretions. The fact that atropin completely suspends the effect of pilocarpin on the secretions has led pharmacologists to believe that the drug acts by stimulating the peripheral fibers of the nerves supplying the various glands.

Pilocarpin is not much used in dental therapeutics. In *acute uremia* large doses 1/6–1/3 gr. (0.01–0.02 Gm.) may be used in conjunction with external heat (hot air or hot vapor baths). The drug is sometimes used for its diaphoretic effect in *acute rheumatism* and *acute coryza.*

SPIRITUS ÆTHYLIS NITRITIS—U.S.P.

(Spirit of Ethyl Nitrite; Sweet Spirit of Niter.)

Spirit of ethyl nitrite or **spirit of nitrous ether,** commonly called sweet spirit of niter, is an alcoholic solution of ethyl nitrite, containing not less than 4 per cent. of pure ethyl nitrite. It occurs as a clear, volatile, inflammable liquid, having a yellowish or greenish tint, a pleasant ethereal odor, and a sharp, burning taste. It should be kept in well-stoppered bottles away from light. The dose is from 10–120 min. (0.6–8.0 cc.), depending upon the age of the patient.

Physiologic Action and Therapeutics.—Spirit of nitrous ether acts as a mild diaphoretic, diuretic, and antispasmodic. Its diaphoretic effect is more pronounced than its diuretic effect when the patient is kept well under cover after its administration; the action is reversed when the patient is lightly covered. It appears, therefore, that external heat augments its diaphoretic action.

Sweet spirit of niter is used extensively as an antispasmodic remedy in *convulsions* which frequently occur in children during the *eruptive period of the deciduous teeth.* It is best given in small doses, at frequent intervals, well diluted with water.

LIQUOR AMMONII ACETATIS—U.S.P.

(Solution of Ammonium Acetate; Spirit of Mindererus.)

This is a solution of diluted acetic acid nearly saturated with ammonium carbonate. It should be slightly acid in reaction, contain about 7 per cent. of ammonium acetate, and prepared as wanted. Somewhat like sweet spirit of niter, it acts as a feeble diaphoretic or diuretic according as the patient is kept warm or cool. It is largely used in *mild febrile affections of children* as a vehicle for spirit of nitrous ether or preparations of aconite. The average dose is 4 fl. dr. (15.0 cc.). When given in febrile affections it does no harm to the patient even if they be ill for a long period, whereas the coal-tar antipyretics may do much injury under these conditions.

EMETICS

Emetics are agents which produce vomiting (emesis). It is supposed that drugs act to produce emesis either by directly affecting the center in the medulla or by indirectly affecting it through irritation of the sensory nerve endings in the stomach. There is little doubt that the action of apomorphin is a direct one; ipecac and antimony undoubtedly act both directly and indirectly; and all evidence goes to show that zinc sulphate, copper sulphate, alum, mustard, and tepid water act, in the main at least, indirectly.

Emetics may be used for one of four purposes:

1. To expel poisons, or undigested food which is causing pain, headaches, etc., from the stomach. For this purpose the indirect or central emetics are the most reliable, especially in cases of poisoning.

2. To expel foreign bodies, false membranes, or excessive secretion from the respiratory tract; the effort of vomiting often being sufficient to dislodge and remove the membrane or foreign body. For this purpose the direct or systemic emetics should be used.

3. To expel foreign bodies from the esophagus. Direct or systemic emetics are here also indicated.

4. To expel mucus and bile from the gall-ducts in catarrhal jaundice. For this purpose the direct or systemic emetics are, perhaps, the most useful.

Emetics are principally used in dental therapeutics for the immediate expulsion of poisons that may have been swallowed accidentally or otherwise. It should be remembered that for this purpose the local emetics are employed.

The chief emetics are:

Apomorphin.	Copper Sulphate.*
Ipecac.	Alum.*
Tartar Emetic.	Mustard.*
Zinc Sulphate.*	Tepid Water, in quantity.

APOMORPHINÆ HYDROCHLORIDUM—U.S.P.

(Apomorphin Hydrochlorid.)

Apomorphin is an artificial alkaloid obtained from morphin by abstracting a molecule of water. It is official as the hydrochlorid, which occurs in minute, grayish-white, acicular crystals, odorless, and having a slightly bitter taste; soluble in about 50 parts of water or alcohol. The average dose as an emetic by mouth is $\frac{1}{6}$ gr. (0.01 Gm.); hypodermic, $\frac{1}{12}$ gr. (0.005 Gm.); as an expectorant, $\frac{1}{20}$ gr. (0.003 Gm.).

Physiologic Action and Therapeutics.—From five to twenty minutes after ingestion, according to the dose and method of administration of apomorphin, vomiting ensues, being repeated three or four times at intervals of about fifteen minutes. The emesis is preceded and attended by slight nausea, but with moderate depression. The entire action of apomorphin is upon the medulla; it is, therefore, a direct or systemic emetic, being the most powerful and certain we possess; and is used whenever such an emetic is indicated. The drug turns green from the action of light, but this does not appear to affect its action as an emetic. An average dose will generally produce emesis in six minutes by the watch.

IPECACUANHA—U.S.P.

(Ipecac.)

Ipecac is the *root* of *Cephaëlis Ipecacuanha*, or *Cephaëlis acuminata*, a perennial shrub growing in Brazil and other South American states. It contains two alkaloids, *emetin* and *cephaëlin;* and, according to some authorities, also *psychrotin*. The average dose of the powdered drug as an emetic is 15 gr. (1.0 Gm.); as an expectorant, $\frac{1}{2}$ gr. (0.03 Gm.).

The following are its official preparations:

Fluidextractum Ipecacuanhæ, U.S.P. *Dose*, as an emetic, 15–30 min. (1.0–2.0 cc.); as an expectorant, 2–5 min. (0.1–0.3 cc.).

Syrupus Ipecacuanhæ, U.S.P. *Dose*, as an emetic, 2–4 fl. dr. (8.0–15.0 cc.); as an expectorant, 10–60 min. (0.6–4.0 cc.).

Pulvis Ipecacuanhæ et Opii, U.S.P. (Dover's Powder; Ipecac, 1 part; Opium, 1 part; Sugar of Milk, 8 parts). *Dose*, 5–10 gr. (0.3–0.6 Gm.).

The action of ipecac is dependent almost entirely on its emetin content. This alkaloid is now official as the hydrochlorid.

EMETINÆ HYDROCHLORIDUM—U.S.P.

This product is the hydrochlorid of the alkaloid emetin, obtained from ipecac. It contains various amounts of water of crystallization, and should be preserved in dark amber-colored vials, protected from light. The average hypodermic dose is ⅓ gr. (0.02 Gm.). Most pharmaceutical houses prepare the drug in solution in ampules, containing the average dose.

Alcresta Ipecac Tablets.—These are tablets containing an absorption product of ipecac alkaloids with hydrated aluminum silicate, each tablet representing 10 gr. (0.64 Gm.) of ipecac. The dose is 2 or 3 tablets three times a day for a period of four to six days, then discontinued for two or three days if the laxative effect is too pronounced. In the stomach where the content is acid, the tablets disintegrate but do not liberate the ipecac alkaloids. The latter are released in the intestines where the secretions are alkaline, and thus enter the circulation. Alcresta ipecac tablets afford a means of administering ipecac by way of the mouth without the nausea which is certain to follow the mouth administration of the drug in other forms.

Physiologic Action and Therapeutics.—Ipecac is a powerful irritant to the mucous membranes of the respiratory tract when the powdered drug is inhaled. Its prolonged application to the skin produces much irritation, and even vesication, pustulation, and ulceration often result. The drug is claimed to possess some antiseptic properties. Internally administered in small doses, ipecac acts as a stimulant to the salivary and gastric glands; its action here is not unlike that of the vegetable bitters. In large doses the drug is a powerful irritant and emetic, the emesis in all probability being due to a local irritation of the peripheral sensory nerve endings in the stomach.

The drug also exerts a favorable influence on the bronchial mucous membrane, acting as a sedative expectorant, and is frequently employed as a component of cough mixtures. Ipecac, though not very prompt in its action, is a safe and reliable emetic. It is especially useful in children, with whom it is extensively used

to *expel irritant material from the stomach.* The syrup of ipecac is a useful preparation here. Children swallow it readily and unsuspectingly.

The drug has been empirically used for a variety of purposes other than that of an emetic and expectorant. It is used as an antiemetic, antidysenteric, diaphoretic, etc. Recently ipecac, or its alkaloid emetin, has gained a wide reputation in *amebic dysentery* and all other diseases due to *pathogenic amebas.* It has been claimed that *periodontoclasia* is caused by pathogenic amebas; and, on this basis, emetin is recommended in the treatment of this disease (which see, p. 522). The drug may be administered in the form of alcresta ipecac tablets.

ANTIMONII ET POTASSII TARTRAS—U.S.P.

(Antimony and Potassium Tartrate; Tartar Emetic; $2K(SbO)C_4H_4O_6.H_2O$.)

Tartar Emetic occurs in the form of colorless, transparent crystals or as a white granular powder, odorless, and having a sweetish, metallic taste; soluble in 12 parts of water, and practically insoluble in alcohol. The average dose as an emetic is 1 gr. (0.06 Gm.); as an expectorant, 1/12 gr. (0.005 Gm.). The official preparations are

> Mistura Glycyrrhizæ Compositæ, U.S.P. (contains Extract of Glycyrrhiza, 3; Antimony and Potassium Tartrate, 0.024; Syrup, 5; Acacia, 3; Camphorated Tincture of Opium, 12; Spirit of Nitrous Ether, 3; Water to make 100). *Dose,* 2½ fl. dr. (10.0 cc.).
>
> Syrupus Scillæ Compositus, U.S.P. (contains Tartar Emetic, 2; Squill, Senega, Sugar, and Water to make 1,000). *Dose,* 5–60 min. (0.3–4.0 cc.).

Physiologic Action and Therapeutics.—Tartar emetic is an irritant and acts as an emetic and expectorant. The drug is fast falling into disuse in medical practice, having been displaced largely by other drugs which are more prompt in their action and less depressing. There is little need of the drug in dental therapeutics, but it has been considered here because of its past record as an emetic, sedative expectorant, diaphoretic, and counterirritant. Adams uses the drug intravenously in the treatment of *bilharzia.* This author practices in Syria and states that many of his Egyptian patients have the disease, and that tartar emetic cures marvelously. Experiments are now being carried on with the drug in *leprosy* and *elephantiasis* with encouraging results.

Tepid water in large quantities generally acts as an emetic.

EXPECTORANTS

Expectorants are drugs which modify the secretion of mucus from the mucous membrane of the air-passages, affect its quantity, and facilitate its expulsion. The exact mode of their action is not well understood. Those that promote secretion and render it less viscid in character, and, therefore, more easily removed, are generally called *sedative expectorants*. Examples of this class are:

Ipecac.*	Tartar Emetic.*
Apomorphin.*	Potassium Citrate.*

Those drugs which stimulate the mucous membrane of the respiratory tract and lessen the quantity of sputum are termed *stimulant expectorants*. The most important are:

Ammonium Chlorid.	Squill.
Eucalyptus (Eucalyptol).*	Benzoic Acid.*
Oil of Myrtle.	

AMMONII CHLORIDUM—U.S.P.

(Ammonium Chlorid; Sal Ammoniac; NH_4Cl.)

Ammonium chlorid occurs as a white crystalline powder, odorless, and having a cooling, saline taste; soluble in 2.6 parts of water and in 100 parts of alcohol. The drug has the peculiar physical property of passing, when heated, directly from the solid to the gaseous state, and on cooling, from the gaseous directly to the solid state. In other words, it differs from most salts in that it cannot be liquefied by heat. The average dose is 5 gr. (0.3 Gm.). The following preparation is official:

> Trochisci Ammonii Chloridi, U.S.P. (each contains Ammonium Chlorid, 1½ gr. (0.1 Gm.); Extract of Licorice, 3 gr. (0.2 Gm.); with Tragacanth, Sugar, and Syrup of Tolu). *Dose*, 1–2 troches.

Physiologic Action and Therapeutics.—Administered in moderate doses by the mouth, ammonium chlorid acts chiefly as a stimulant to the mucous membrane of the respiratory tract and perhaps, also, of the stomach and bowel. It increases the quantity and renders less viscid the mucous secretion. The drug for the most part is eliminated in the urine unchanged.

Ammonium chlorid is extensively employed as a stimulant expectorant in *acute bronchial catarrh, subacute and chronic pharyngitis*, etc.

Incompatibles.—The drug is incompatible with alkalies, mineral acids, tartaric acid, and the soluble salts of silver and lead.

SCILLA—U.S.P.

(Squill.)

Squill is the cut and dried fleshy inner *bulb scale* of the white variety of *Urginea maritima*, a perennial herb, growing on the shores of the Mediterranean Sea. It is supposed to contain several active principles, no one of which, when isolated, fully represents the activity of the crude drug. The average dose is 1½ gr. (0.1 Gm.). The official preparations are:

Acetum Scillæ, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Tinctura Scillæ, U.S.P. *Dose*, 5–20 min. (0.3–1.3 cc.).
Fluidextractum Scillæ, U.S.P. *Dose*, 1–3 min. (0.06–0.2 cc.).
Syrupus Scillæ, U.S.P. *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).
Syrupus Scillæ Compositus, U.S.P. (contains fluid extract of Squill, 8 per cent.; fluid extract of Senega, 8 per cent.; Tartar Emetic, 2 per cent.). *Dose*, 10–60 min. (0.6–4.0 cc.).

Physiologic Action and Therapeutics.—The action of squill somewhat resembles that of digitalis, though it is much less powerful. It also acts as a stimulant expectorant and a diuretic. The syrup of squill is a common component of cough mixtures.

OLEUM MYRTI (Nonofficial)

(Oil of Myrtle; Myrtol.)

Oil of myrtle is a greenish-yellow, volatile oil, distilled from the *leaves* and *flowers* of *Myrtus communis*, the common European myrtle. Its properties are almost identical with those of eucalyptol. The average dose is 5 min. (0.3 cc.). It may be employed as a stimulant expectorant in cases of *cold in the head*. A few minims may be added to a basin of hot water and the fumes inhaled. It may also be taken internally by placing 2–3 min. (0.13–0.2 cc.) of the oil on a blank sugar tablet or a piece of loaf-sugar. Harlan recommends the drug for the treatment of *gangrenous pulps*, but it is of doubtful value, other remedies for this purpose having completely displaced the essential oils.

SIALOGOGUES

Sialogogues are drugs or remedies which stimulate the salivary and buccal mucous glands, increasing the secretion and flow of saliva and buccal mucus. There are many diseases and conditions

which change the character and flow of the mouth secretions. Among the men who have experimented with mouth secretions in relation to health and disease may be mentioned Black, Miller, Williams, Michaels, Kirk, Acre, Hinkins, Cook, Bunting, and Howe. Michaels claims that the saliva is pathognomonic of certain diseases, the diagnosis being made by physical and chemic examinations of the saliva. Cook has shown that astringent mouth-washes interfere for hours with the action of ptyalin upon starchy food. The mixed saliva is normally alkaline in reaction. The author, some years ago collaborating with Hinkins and Cook, spent considerable time investigating the cause of erosion. One point established beyond doubt, which has also been mentioned by other investigators, was that the saliva in typical cases of erosion is *always acid*. Hinkins has repeatedly called attention to the fact that simply holding the mouth open for any length of time, as in dental operations where the rubber dam is used, materially affects the character and flow of saliva. Chewing a piece of clean wood, rubber, and even gum or tobacco, augments the flow of saliva, as does also the smell of victuals. Many drugs also produce a sialogogue effect, the most important of which have been discussed under other headings. They are:

Pilocarpus (Jaborandi).* Potassium Chlorate.*
Mercurials.* Echafolta.*
Iodin Compounds.* Tobacco.*
Acetic Acid.*

To collect saliva for experimental purposes almost any clean substance may be chewed; the mere movements of the jaws stimulate the glands. Another means is to place the tongue on the roof of the mouth and inhale dilute acetic acid through the mouth. This stimulates the secretion especially from the sublingual gland.

The rôle played by the saliva in mouth diseases is by no means settled, and this field offers an excellent opportunity for further investigation to those scientifically inclined.

CARMINATIVES

Carminatives are drugs that aid in the expulsion of gas from the stomach or intestines. The gas found in the alimentary canal comes from various sources: it may have been swallowed with the food, formed by the action of acid upon the carbonates contained in the food and saliva or it may be generated through fermentation or putrefaction of the stomach contents; fermentation being the most common cause of abnormal accumulation of gas. Although drugs

of this class are chiefly valuable in the expulsion of gas already formed, they also prevent, in greater or less degree, the formation of flatus, for, by quickening the gastric circulation, they doubtless stimulate glandular activity, thus acting as stomachics by aiding digestion and lessening fermentation. Carminatives are frequently combined with purgative drugs; here they act as *correctives* by modifying or correcting the griping pain which purgatives are likely to induce when given alone.

Most of the drugs belonging to this class are aromatics containing essential oils as their chief active constituent. Alcohol, ether, and chloroform are the exceptions. The principal carminatives are:

Capsicum.*	Cardamom.	Caraway.
Pepper.	Cloves.*	Fennel.
Nutmeg.	Cinnamon.*	Coriander.
Ginger.	Anise.	Mustard.*
Peppermint.*	Allspice.	Alcohol.*
Spearmint.	Sassafras.	Ether.*
	Chloroform.*	

PIPER (Nonofficial)

(Black Pepper.)

Black pepper is the *unripe fruit* of *Piper nigrum*, a climbing vine cultivated in the East Indies. It contains a crystalline neutral principle, *piperin*, a volatile oil, and a pungent resin. The average dose of ground pepper is 8 gr. (0.5 Gm.).

Both the drug and the following preparation were formerly official:

Oleoresina Piperis, U.S.P. IX. *Dose*, ½–2 min. (0.03–0.1 cc.).

Pepper is a carminative and is largely used as a condiment.

MYRISTICA—U.S.P.

(Nutmeg.)

Nutmeg is the *dried ripe seed* of *Myristica fragrans*, an evergreen tree growing in the Molucca Islands and other East India islands. It contains a volatile oil, to which its aromatic properties are due, also a fixed oil. The average dose is 8 gr. (0.5 Gm.). The volatile oil is official.

Oleum Myristicæ, U.S.P. *Dase*, 1–5 min. (0.06–0.3 cc.).

Nutmeg is used as a condiment. It also enters as an aromatic into many of the official aromatic and compound preparations.

Mace is the ground fleshy covering (arillode) of nutmeg. It is used as a condiment.

ZINGIBER—U.S.P.

(Ginger.)

Ginger is the *dried rhizome* of *Zingiber officinale*, a perennial herb which grows in tropical countries. It contains a volatile oil, having the odor of ginger, and a viscid resinous principle, having a hot, pungent taste. The average dose is 15 gr. (1.0 Gm.).

The following preparations are official:

Tinctura Zingiberis, U.S.P. *Dose*, 20–60 min. (1.3–4.0 cc.).
Fluidextractum Zingiberis, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Pulvis Rhei Compositus, U.S.P. (Rhubarb, 25 parts; Magnesium Oxid, 65 parts; Ginger, 10 parts). *Dose*, 30 gr. (2.0 Gm.).
Syrupus Zingiberis, U.S.P. *Dose*, ½–4 fl. dr. (2.0–15.0 cc.).

Ginger is used as a carminative and as a flavoring agent, and enters as a constituent into several aromatic and compound preparations.

MENTHA VIRIDIS—U.S.P.

(Spearmint.)

Spearmint is the *dried leaves* and *tops* of *Mentha spicata*, a perennial herb growing wild in the woods and along the roadsides of Europe and North America. Its official preparations are:

Oleum Menthæ Viridis, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).
Spiritus Menthæ Viridis, U.S.P. *Dose*, 10–30 min. (0.6–2.0 cc.).
Aqua Menthæ Viridis, U.S.P. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Therapeutically, spearmint is almost equivalent to peppermint, and is used for practically the same purpose.

CARDAMOMI SEMEN—U.S.P.

(Cardamom Seed.)

Cardamom seed is the *dried seed* of *Elettaria Cardamomum* recently removed from the capsules, a perennial herb, cultivated in the mountainous portions of India. Its active principle is a volatile oil, of which it contains about 5 per cent. The official preparations are:

Tinctura Cardamomi, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Tinctura Cardamomi Composita, U.S.P. (contains also Cinnamon, Caraway, Cochineal, and Glycerin). *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).

Pulvis Aromaticus, U.S.P. IX. Aromatic Powder (contains Cardamom Seed, Ginger, Cinnamon, and Nutmeg). *Dose*, 10–30 gr. (0.6–2.0 Gm.).

Cardamom seed also enters into several of the official aromatic and compound preparations. It is used as a flavoring agent and carminative.

ANISUM (Nonofficial)

(Anise.)

Anise is the *small fruit* of *Pimpinella Anisum*, a small plant cultivated in Southern Europe and North America. It contains a volatile oil, having the characteristic odor of the drug, and a sweetish, aromatic taste. Its preparations follow:

Aqua Anici, U.S.P. *Dose*, 2–8 fl. dr. (8.0–30.0 cc.).
Oleum Anici, U.S.P. *Dose*, 2–5 min. (0.13–0.3 cc.).
Spiritus Anici, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).

The drug also enters into many of the official aromatic and compound preparations. It is used chiefly as a flavoring agent.

PIMENTA (Nonofficial)

(Allspice.)

Allspice is the *nearly ripe fruit* of *Pimenta officinalis*, an evergreen tree growing in the West Indies and South America. It contains a volatile oil, the active constituent of which is *eugenol*. The oil was formerly official, and is a constituent of spirit myrica, or bay-rum.

Oleum Pimentæ, U.S.P. IX. *Dose*, 1–5 min. (0.06–0.3 cc.).

SASSAFRAS (Nonofficial)

Sassafras is the *bark* of the *root* of *Sassafras variifolium*, a shrubby tree growing in the eastern and central parts of North America. The pith was formerly official (*Sassafras medulla, U.S.P. VIII*). It contains an aromatic, fragrant, volatile oil and tannic acid, the bark of the root containing these active constituents.

The official preparation is:

Oleum Sassafras, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).
Mucilago Sassafras Medullæ, U.S.P. VIII (2 per cent.). *Dose*, 1–8 fl. dr. (4.0–30.0 cc.).

Sassafras oil also enters into the official compound syrup of sarsaparilla. The mucilage is an excellent demulcent in cases of *drug*

poisoning, and a tea made by steeping the bark of the root is extensively used by the lay American as a "spring tonic."

CARUM—U.S.P.

(Caraway.)

Caraway is the *dried ripe fruit* of *Carum Carvi*, a native herb of Asia, but cultivated in Europe and North America. Its active constituent is a volatile oil. Caraway is used as a flavoring agent, and as such it enters into the official compound tincture of cardamom. The oil is official:

Oleum Cari, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).

FŒNICULUM (Nonofficial)

(Fennel.)

Fennel is the *fruit* of *Fœniculum vulgare*, a plant growing chiefly in Southern Europe. It contains an aromatic oil. The official preparations are:

Aqua Fœniculi, U.S.P. *Dose*, 1–8 fl. dr. (4.0–30.0 cc.).
Oleum Fœniculi, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).

As a flavoring agent fennel enters into compound licorice powder, compound spirit of juniper, and compound infusion of senna.

CORIANDRUM (Nonofficial)

(Coriander.)

Coriander is the *dried ripe fruit* of *Coriandrum sativum*, an herb grown in all parts of Europe and the United States. It contains a volatile oil, which is official.

Oleum Coriandri, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).

The oil is used as a flavoring agent, and as such it enters into the syrup of senna and compound spirit of orange.

FLAVORING AGENTS

Flavoring agents are used to mask the taste of nauseous drugs, to flavor foods, drinks, etc. The chief flavoring agents are:

Lemon.	Rose.
Orange.	Sugar and Sugar of Milk.
Vanilla.	Honey.*
Lavender.	Saccharin.
Sarsaparilla.*	Glucose.

Persio (Cudbear).

LIMON (Nonofficial)

(Lemon.)

Lemon is the *ripe fruit* of *Citrus medica Limonum*, a tree cultivated in most semitropical countries. The rind contains a volatile oil, and the juice, citric acid. The following preparations are official:

Limonis Cortex, U.S.P. (Fresh Rind).
Limonis Succus, U.S.P. VIII (Juice). *Dose*, 1–4 fl. oz. (30.0–120.0 cc.).
Tinctura Limonis, U.S.P. *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).
Oleum Limonis, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).
Acidum Citricum, U.S.P. *Dose*, 5–20 gr. (0.3–1.3 Gm.).
Syrupus Acidi Citrici, U.S.P. (1 per cent.). *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

The oil also enters into other official preparations as a flavoring agent. Lemon juice has been used in *scurvy*, both as a preventive and curative agent. In the form of cold lemonade it makes a pleasant refrigerant drink. Hot lemonade is a useful remedy for *colds*. Both the fresh rind and juice are used extensively as flavoring agents, and will remove fruit stains from the skin, providing soap has not been used first.

AURANTIUM (Nonofficial)

(Orange.)

There are two varieties of **orange**: Sweet orange, *Citrus aurantium*, and bitter orange, *Citrus vulgaris*. The following preparations are official:

Aurantii Amari Cortex, U.S.P. *Dose*, 15–30 gr. (1.0–2.0 Gm.).
Tinctura Aurantii Amari, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Aqua Aurantii Florum, U.S.P. Aqua Aurantii Florum Fortior, U.S.P. IX. *Dose*, indefinite.
Syrupus Aurantii Florum, U.S.P. *Dose*, indefinite.
Auranti Dulcis Cortex, U.S.P. *Dose*, 15–30 gr. (1.0–2.0 Gm.).
Tinctura Aurantii Dulcis, U.S.P. *Dose*, 1–2 fl. dr. (4.0–8.0 cc.).
Syrupus Aurantii, U.S.P. *Dose*, indefinite.
Oleum Aurantii, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).
Elixir Aromaticum, U.S.P. *Dose*, 1–4 fl. dr. (4.0–15.0 cc.).

Both varieties of orange are used almost exclusively as flavoring agents.

VANILLA (Nonofficial)

Vanilla is the *fruit* of *Vanilla planifolia*, a perennial climbing plant, native of the West Indies and tropical America. Its characteristic odorous principle is *vanillin*. The tincture was official:

> Tinctura Vanillæ, U.S.P. VIII (10 per cent.). *Dose*, a few minims, according to the strength of flavor desired.

Vanilla is employed chiefly as a perfume and as a flavoring agent.

LAVANDULA (Nonofficial)

(Lavender.)

Lavender is the *flowers* of *Lavandula officinalis*, a native shrub of Southern Europe. It contains a fragrant volatile oil, tannic acid, and resin. The official preparations are:

> Oleum Lavandulæ Florum, U.S.P. *Dose*, 1–5 min. (0.06–0.3 cc.).
> Spiritus Lavandulæ, U.S.P. *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).
> Tinctura Lavandulæ Composita, U.S.P. *Dose*, ½–1 fl. dr. (2.0–4.0 cc.).

The compound tincture is also an ingredient of Fowler's solution. The preparations of the drug are used only for their agreeable flavor.

ROSA—U.S.P.

(Rosa Gallica U.S.P. IX; Red Rose.)

Red rose is the *dried petals* of *Rosa gallica*, a species of red rose cultivated extensively in Western Asia and Southern Europe. It contains a volatile oil, tannic acid, sugar, and mucilage. The formerly official oil of rose is distilled from the fresh flowers of the Damascus rose (*Rosa damascena.*) The following are its official preparations:

> Fluidextractum Rosæ, U.S.P.
> Mel Rosæ, U.S.P. (12.5 per cent. of the fluid extract in Honey).
> Aqua Rosæ Fortior, U.S.P. (Water saturated with Oil of Rose).
> Aqua Rosæ, U.S.P. (equal parts of Stronger Rose Water and Distilled Water).

Preparations of rose also enter into several official preparations as flavoring agents. The ointment of rose water (cold cream) makes

an excellent application for the hands and face. A splendid lotion for the hands is: Phenol (95 per cent.) 6 min. (0.36 cc.); borax, ½ dr. (2.0 Gm.); rose water and glycerin, of each 1½ fl. oz. (45.0 cc.).

SUCROSUM—U.S.P. AND LACTOSUM—U.S.P.

(Saccharum, U.S.P. IX; Cane-sugar; Saccharum Lactus, U.S.P. IX; Sugar of Milk; Lactose.)

Cane-sugar is refined from *sugar-cane, Saccharum officinarum,* from various species of *broom-corn, Sorghum,* and from one or more varieties of *sugar-beet, Beta vulgaris.* A saturated solution is official as:

Syrupus, U.S.P. (Simple Syrup).

Sugar enters as a flavoring agent, preservative, vehicle, or excipient into many official compound preparations. Sugar of milk is the sugar obtained from the whey of cow's milk. It is harder, less soluble, less fermentable, and less sweet than ordinary sugar, and is largely used as a diluent for powders, as in Dover's powder.

GLUSIDUM—U.S.P.

(Glucide; Benzosulphinidum, U.S.P. IX; Saccharin)

Saccharin is obtained from the *coal-tar* derivative, *toluene.* It occurs in a light, white, crystalline powder, is odorless, and possesses 500 times the sweetening power of cane-sugar. It is soluble in 290 parts of water, more so in alcohol or glycerin, and readily soluble in alkaline solutions.

Saccharin is used as a flavoring agent for mouth-washes, tooth-pastes, tooth-powders, etc. Internally, in large doses, it retards digestion and, therefore, metabolism. The average dose is 3 gr. (0.2 Gm.).

GLUCOSUM—U.S.P.

(Glucose; Liquid Glucose.)

Glucose is a product obtained by the incomplete hydrolysis of starch, and consists chiefly of *dextrose* and *dextrins.* It is a colorless or slightly colored, thick, syrupy liquid; odorless and has a sweet taste; freely soluble in water, and sparingly soluble in alcohol. Glucose is used as a flavoring agent; but should not enter as such into dentifrices, as it is a fermentable sugar and its fermentation in the mouth produces the acid (lactic) which causes *caries of the teeth.*

PERSIO (Nonofficial)

(Cudbear.)

Cudbear occurs as a purplish-red powder prepared from species of *Rocella* De Candolle, or other lichens. The drug is not used as a flavoring agent, but solutions of it are employed extensively for coloring purposes. An aqueous or alcoholic preparation of cudbear is of a deep red color which is rendered lighter in tint by the addition of acids and changed to purplish red on the addition of alkalies. There are no official preparations, but the National Formulary gives directions for the preparation of a *tincture* and *compound tincture of cudbear*. These are the preparations used for coloring solutions of various kinds (mouth-washes, etc.), as well as the powdered cudbear itself.

BIOLOGIC PRODUCTS

The advanced therapy of many *infectious diseases* includes the intelligent use of *biologic products.* Many of the systemic diseases of this character are known to have a direct relation to diseased mouth and throat conditions (teeth and tonsils). It is, therefore, important that the student and practitioner of dentistry understand the principles upon which this therapy is based; and be familiar with the nature and character, as well as the indications and uses of the products obtained from Biologic Laboratories. In this connection it should be remembered that before an organism can be said to be the causative agent in a given disease, it must conform to Koch's laws or postulates.

1. It must be present and discoverable in every case.
2. It must be isolated and cultivated.
3. When inoculated into experimental animals the culture must give rise to the disease.
4. It must again be isolated from the experimental animal and grown in pure culture.

An infectious disease is one caused by the invasion of micro-organisms into the tissues of an animal (or plant). The invading germ gains admission into the body and tissues in various ways; through the air into the respiratory passages (mouth, nose, throat and lungs); through food and water into the digestive tract (stomach and intestines); through cuts and abrasions of the skin and mucous membranes (inflamed and bleeding gums); through the canals of pulpless teeth; and through direct injection into the blood stream.

When these bacteria have thus gained entrance into the tissues, where they find the proper food, moisture and temperature necessary to their growth, they multiply and proliferate rapidly; and during this growth they produce substances known as **Toxins,** which are poisons to the tissues of the body. Sometimes these poisons remain largely within the cell body of the bacteria and are given off at the death of the germ. Such poisons are called *intracellular toxins.* An example is the *staphylococcus pyogenes aureus,* the germ which causes boils. In other instances the poisons are excreted by the bacteria into the tissues or blood stream and may be thus carried to various parts of the body, attacking those parts which are subnormal

and have the least resistance. Poisons of this kind are called *extracellular toxins*. Examples of such germs are the *bacillus diphtheriæ* and *bacillus tetani*, which cause, respectively, diphtheria and tetanus (lock-jaw). The *streptococcus viridans* also belongs to this class of germs, and is of special interest to dentists for the reason that the poisons are elaborated in pyorrheal pockets about the teeth and in dental granulomas and dento-alveolar abscesses in the periapical region. The poisons being of the extracellular variety are continually formed and constantly charging the blood stream as long as the infection in these areas is present. Thus may follow diseases of the joints (arthritis), heart (endocarditis), kidneys (nephritis), etc. It will be observed then how absolutely essential it is for the dentist to eradicate all infections about the teeth.

Nature is constantly on the alert to protect the body against the invasion of these germs and their poisons. Stimulated by the bacterial toxins, the body tissues react, calling forth additional cellular activity and produce substances known as **Antitoxins** and **Antibodies.** The antitoxins are chemic substances which destroy the poisonous nature of the toxins. The antibodies are substances which antagonize the bacteria themselves, actually killing and destroying them, or preventing their growth and proliferation. Thus when an infection has taken place there is an incessant struggle against the invading organisms by the tissue cells in their effort to rid the body of the disease germs and to neutralize their toxic effects.

The manufacture and use of biologic products are based upon these principles; and, before considering the subject further, it is well that the student should understand what is meant by the term **Immunity.** This is recognized as the ability or power which enables certain individuals to resist disease. There are two kinds of immunity—*natural* and *acquired*. Natural immunity is that which exists in a normal, healthy animal or human being. In this case the tissues of such bodies contain or produce substances which are antagonistic to the pathogenic bacteria. Hence these germs cannot grow in the body and no disease results. Certain persons appear to have a definite immunity to scarlet fever and diphtheria, although they have never had the disease; others repeatedly pass through epidemics of various kinds, such as measles, pertussis (whooping cough), etc., without becoming infected. Acquired immunity is the resistance to a disease which exists either after an attack or sub-attacks of that disease, or after inoculation with some specific culture, vaccine, antitoxin or serum. An example of the first is a person who has had smallpox or the immunity that comes in later

years of youth and adult life to diphtheria; an example of the second is a person who has been vaccinated with smallpox virus or has had injected an anti-diphtheritic serum—both are immune to smallpox and diphtheria, and the immunity has been acquired. There are two types of acquired immunity—*active* and *passive*. Active immunity is that which is developed by the individual himself, because he has had the disease or because the immunity to it has been artificially produced. This latter is known as "vaccination." Passive immunity is a form of immunity that depends upon defensive factors not originating in the person or animal protected, but is passively acquired by the injection of a serum from another that has acquired an active immunity to the disease or infection in question.

This brings us to a discussion of biologic products, which may be divided into at least three general classes—Antitoxins, Serums and Vaccines.

ANTITOXINS

Antitoxins are among the simplest and most useful of the antibodies. As the name implies, they antagonize toxins. Though toxins may be excreted by plants other than the bacteria and some animals, *e.g.*, in snake venoms, the typical toxins are the soluble poisons thrown off by diphtheria and tetanus bacilli.

Diphtheria and tetanus are dangerous diseases almost entirely because of the action of these toxins and, conversely, their prevention and cure, when the organisms have once gained entrance to the body, depends on the work of the particular antitoxin. Though the presence of the toxin stimulates the body to produce antitoxin, this active immunity may not be enough to save life; and, at any rate, assistance by the injection of antitoxin, ready made in the blood-serum of another animal, hastens the cure or may prevent the disease. When the disease is developing the body does not produce antibodies fast enough to combat the deadly germs—hence the need of calling for help from the field of medicine.

The antitoxins for both diphtheria and tetanus are official: Serum Antidiphthericum, U.S.P. and Serum Antitetanicum, U.S.P. These antitoxins are obtained from the coagulated blood of the horse, or other large domestic animal which has been properly immunized against the toxin produced by the germ causing the disease. Diphtheria antitoxin is measured in *units*. A unit is that amount of antitoxin which will save the life of a guinea pig if injected together with a definite dose of toxin, called the L_+ dose. Normal guinea pigs of 250 grams weight are used for the tests, and

neither the pigs themselves, nor their mothers, should have been previously used in testing toxin or antitoxin. The strength of tetanus antitoxin is determined in practically the same way as diphtheria antitoxin, except the *unit* is different. A unit of tetanus antitoxin is the amount required to neutralize 1000 M.L.D. (*minimal lethal dose*) of tetanus toxin, for a 350-gram guinea pig. The U. S. Public Health and Marine Hospital laboratories supplies the different manufacturers with standardized toxin and antitoxin for testing purposes. Diphtheria and tetanus are not dental diseases, nor have they any direct relation to diseased mouth conditions; therefore, the dentist will not be called upon to administer the commercial antitoxins prepared for these diseases.

SERUMS

Serums are more complex in action and much less satisfactory for therapeutic purposes than are the antitoxins. With these products the contained antibodies are expected to resist the bacteria themselves—not simply neutralize their toxins, as is the case with antitoxins. In the manufacture of serums proper, horses are immunized by inoculation first, with dead cultures, and, secondarily, with increasing doses of living culture of the specific bacteria, until their blood contains substances that directly or indirectly destroy either the life or the activity of these specific bacteria. If the toxin of the microorganism is its chief pathogenic weapon, then the body cells produce an *antitoxin;* if, however, the offensive substance is an endotoxin, as in the typhoid infection, then the body produces among other antibodies *bacteriolysins*, which will break down the bacteral cells; in other infections, *opsonins* which cause the phagocytes to destroy the bacteria. The substances in the immune serum that destroy the life or the activity of the specific germ are collectively spoken of as *antibodies*. They have never been isolated as specific chemic substances, but their presence in the serum is assumed from their definite effects on bacteria. The names given to the more important of these antibodies are *bacteriolysins*, *bacteriotropins*, *opsonins* and *agglutinins*. Of these antibacterial substances, the bacteriolysins are those which both kill and dissolve the bacteria, and are considered to be the antibacterial bodies proper. For example, take a serum from an animal immunized against the streptococcus germ, and put into it some living streptococci; after a brief period of incubation, an examination will show that the streptococci are not only killed but have been dissolved as well. This phenomenon is called *bacteriolysis*.

Aside from the direct killing of the bacteria by the blood serum, the invaders may be taken up by the leukocytes—though not, as a rule, until they have been acted upon by other substances in the serum, mentioned above as bacteriotropins and opsonins, according to whether they resist moderate heat or not.

The agglutinins are antibodies which act directly, causing the bacteria to gather in clumps. They are valuable in diagnosis on account of their specificity, but probably have no important action in protecting the human organism from an infection.

Indications for Serums.—In severe infections already developed, when prompt establishment of immunity (passive) is necessary to the body cells, the specific serum is indicated. Serums should also be used as prophylactic agents in warding off infections which have a relatively short incubation period.

Among the more important antibacterial serums may be mentioned *antistreptococcus serum*, *antistaphylococcus serum*, and *antipneumococcus serum.*

VACCINES

Vaccines or bacterins are suspensions of killed bacteria in physiologic salt solution, usually with the addition of some preservative such as 0.4 per cent. of cresol (tricresol) or 0.5 per cent. of phenol. More or less confusion has existed in the minds of physicians and dentists as well as of the laity in regard to the proper use of the words "serum" and "vaccine." A serum, as has been explained, is the blood serum of an animal which has been immunized against the specific bacterial toxins or against the bacteria themselves, and contain the necessary antibodies to be directed against the toxins or against the bacteria themselves, upon injection into the body. On the other hand vaccine (*vacca*—a cow) was the term first used by Jenner to designate the cowpox virus which he used for protective inoculation against *smallpox*. Later Pasteur applied it to suspensions of dead or attenuated bacteria. Today we qualify it slightly and speak of *bacterial vaccines*. It should be remembered that vaccines contain no antibodies.

An *autogenous vaccine* is one made from the bacteria infecting the person immunized. A *stock vaccine* is one made from standard cultures of the germ. A *mixed vaccine* is one prepared from more than one species of bacteria.

Indications for Vaccines.—When the purpose of using the remedy is only to stimulate the body cells to a greater production of anti-

bodies, vaccines are indicated. Prophylaxis by active immunization is usually to be preferred, except in cases mentioned under "indications for serum therapy." Not infrequently it is desirable to combine the two forms of immunization since the serum will give prompt and immediate protection at a critical moment and the vaccine will stimulate the formation of an excess of antibodies, which will reinforce and maintain the immunity for a longer period.

The use of bacterial vaccines is associated with the development of the opsonic theory; but it is claimed by those in authority that the opsonic index as a measure of immunity is open to question. It may be said that bacterial vaccines are of particular value in localized affections, especially those due to infection by the staphylococcus and streptococcus germs. The importance of focal infections as an etiologic factor of local and of general disease is now well recognized. Foci of infections (circumscribed areas of tissues infected with pathogenic microorganisms) may be *primary* and *secondary*. Primary foci are usually located in tissues communicating with mucous or cutaneous surfaces (tonsils, teeth, etc.). Secondary foci are the direct results of infection from other foci through contagious tissues or at a distance through the blood stream or lymph channels (hemotogenous or lymphogenous transportation).

Dental literature to-day is replete with articles on the relation of focal infection to systemic disease. It has been definitely shown by Murphy, Billings, Rosenow, Rhein, Grieves, Hartzell, Price, and others that infections about the teeth, especially from dental granulomas and dentoalveolar abscesses, may result in systemic diseases involving the joints, heart, kidneys, stomach, and other organs and tissues. By a series of experiments, Gilmer, Moody, and others, have found that the predominating organism in conditions resulting from a gangrenous pulp, therefore the group active in bringing about the decomposition, is a streptococcus. The use of antistreptococcus vaccines in the treatment of *chronic arthritis* and *other affections* resulting from a streptococcus infection about the teeth or tonsils has been reported by various authorities as affording much relief and in many cases effecting a permanent cure. It is understood that eradication of the foci of infection is of the first and prime importance.

Among the more important bacterial vaccines may be mentioned *streptococcus vaccines* and *typhoid vaccine*. *Smallpox vaccine* or *virus* is the pustular material of vaccinia or cowpox removed under aseptic conditions from vaccinated animals of the bovine species.

DISEASES AND BACTERIAL VACCINES

It is always desirable, when possible, in the presence of an infection, to make bacteriologic studies to determine the exact organism or organisms concerned in the process.

Such determinations will indicate definitely what bacterial vaccine to use, since it is obviously important that the offending organism or organisms be embodied in the appropriate vaccine.

In many cases, however, it is impossible to make such studies, or unwise to postpone treatment until results of the cultural studies are reported, therefore, the following list indicates the vaccines which have been used to advantage and favorably reported upon by physicians in disease processes whose causative agents have become well established by clinical experience and repeated bacteriologic diagnoses.

Abscesses—
Skin—Staphylococcus Vaccine, Staphylococcus Aureus Vaccine.
Rectal—Coli Combined Vaccine.
Renal—Coli Combined Vaccine.
Lung—Pneumococcus Mixed Vaccine.
Acne—Acne Mixed Vaccine.
Anal Fistula—Coli Combined Vaccine.
Arthritis—
Rheumatic Fever—
Rheumatism—Pneumococcus Mixed Vaccine, Streptococcus Vaccine.
Rheumatoid (Arthritis deformans)— Coli Combined Vaccine.
Gonorrheal—
Chronic—Gonococcus Mixed Vaccine.
Acute—Gonococcus Vaccine.
Asthma—Catarrhal Vaccine Combined, Pneumococcus Mixed Vaccine.
Boils—Staphylococcus Vaccine.
Bronchitis—Influenza Mixed Vaccine, Catarrhal Vaccine Combined, Pneumococcus Mixed Vaccine.
Bronchopneumonia—Pneumococcus Mixed Vaccine, Catarrhal Vaccine Combined, Influenza Mixed Vaccine.
Carbunculosis—Staphylococcus Aureus Vaccine.
Catarrh—Catarrhal Vaccine Combined, Influenza Mixed Vaccine.
Cellulitis—Streptococcus Vaccine.
Cerebrospinal Meningitis—(Preventive) Meningococcus Vaccine.
Cholangitis and Cholecystitis—Coli Combined Vaccine.
Colds—See Catarrh.
Coryza—See Catarrh.
Cystitis—Coli Combined Vaccine.
Eczema, infected—Staphylococcus Vaccine.
Empyema—See Lung Abscess.
Enterocolitis—Coli Combined Vaccine.
Epididymitis—Gonococcus Vaccine.

Erysipelas—Streptococcus Vaccine.
Felon—Staphylococcus Vaccine, Streptococcus-Staphylococcus Vaccine.
Fistula—Coli Combined Vaccine.
Furunculosis—Staphylococcus Vaccine, Staphylococcus Aureus Vaccine.
Gleet—Gonococcus Mixed Vaccine.
Gonorrheal Infections—Gonococcus Vaccine, Gonococcus Mixed Vaccine.
Hay Fever—Influenza Mixed Vaccine, Catarrhal Vaccine Combined.
Impetigo—Staphylococcus Aureus Vaccine.
Influenza—Influenza Mixed Vaccine.
Iritis—
Gonorrheal—Gonococcus Vaccine.
Rheumatic—Streptococcus Vaccine, Pneumococcus Mixed Vaccine.
Ischio-rectal Abscess—Coli Combined Vaccine.
Lagrippe—See Influenza.
Laryngitis—Catarrhal Vaccine Combined, Influenza Mixed Vaccine.
Mastitis—Staphylococcus Vaccine.
Meningitis—See Cerebrospinal Meningitis.
Nephritis of Pregnancy—Coli Combined Vaccine.
Ophthalmia, Gonorrheal—Gonococcus Vaccine.
Orchitis—Gonococcus Vaccine.
Otitis Media—Pneumococcus Mixed Vaccine, Streptococcus-Staphylococcus Vaccine, Streptococcus Vaccine.
Paratyphoid Fever—Typhoid Mixed Vaccine.
Paronychia—See Felon.
Pelvic Infections in Women—Gonococcus Vaccine, Gonococcus Mixed Vaccine.
Peritonitis—(Postoperative, Preventive), Streptococcus Vaccine.
Pertussis—Pertussis Vaccine, Pertussis Mixed Vaccine.
Pharyngitis—See Colds.
Phlebitis—Streptococcus-Staphylococcus Vaccine.
Pneumonia—(Preventive) Pneumococcus Vaccine.
(Curative) Pneumococcus Antigen.
Prostatitis—Gonococcus Vaccine.
Puerperal Septicemia—Streptococcus Vaccine, Coli Combined Vaccine.
Pyelitis—Coli Combined Vaccine.
Pyorrhea—Pneumococcus Mixed Vaccine.
Rheumatism—See Arthritis.
Rhinitis—See Catarrh.
Scarlet Fever—(Preventive) Scarlet Fever Vaccine.
Scarlatina—See Scarlet Fever.
Seborrhea—See Acne.
Sycosis—See Acne.
Typhoid—Typhoid Vaccine, Typhoid Mixed Vaccine.
Vulvovaginitis—Gonococcus Vaccine.
Whooping Cough—Pertussis Vaccine, Pertussis Mixed Vaccine.

In the discussion of biologic products and their uses, the author has made no attempt here to go into the subject in detail. He has endeavored to give only the principles underlying the therapy.

FOOD AND DIET

GENERAL CONSIDERATIONS

Dentistry is taking an active part in the solution of many health problems today. Viewed strictly from the standpoint of health the problem of *food* and *diet* is the most important of all. One function of the dentist is to teach people what and how to eat. Those who from habit or disease have learned to eat less daily than they heretofore have done, now realize with surprise how little food, properly selected and properly masticated, is necessary to maintain health. Gluttony is one of the worst and most pernicious habits of the times. It is claiming more victims today; causing more misery, suffering and death than almost all other causes combined. It is important, therefore, that the student and practitioner of dentistry should interest themselves in this timely subject. No Spartan ever stood guard more faithfully or incessantly than should the dentist against this arch despot of gluttony. Give an instinct an inch and, if uncurbed, it is likely to take a mile.

It is not only a question of eating too much. From the health standpoint, eating the wrong things is equally as bad. The real problem of prophylaxis lies deeper than simply the use of artificial means for keeping the mouth and teeth clean. A balanced diet, properly masticated, coupled with correct habits of living and the right mental attitude, will do much toward eliminating the necessity for the tooth brush; for by these rules of life teeth may be kept free of decay and the supporting structures free from periodontoclasia. While the author realizes that this is a broad statement to make—Utopian in character and relates to a system of living which may never be reached, he knows whereof he speaks. It is a statement, the truthfulness of which may be proven by any individual in normal health who has the courage to change the acquired dietetic habits of the times and recover the lost natural appetite and follow this as their guide.

For years our aim has been at *prevention;* the effort has been to eliminate the dentist by teaching people how to so care for their mouth and teeth that they will not need our services. In large measure here we have failed in our ideal; for the services of the dentist are in greater demand today than ever before. But we should not be discouraged. Some failures are but the final stepping stones to complete and ultimate success. Surely in the subject of food and diet we have the lead; we should follow it to the end. To search

for and unfold the hidden mysteries of Nature is the most significant and enticing work of all. No effort along this line is here attempted; but the author hopes to arouse sufficient interest in the subject that further studies may be made; and to this end attention is directed to the work of Dr. E. V. McCollum, of Johns Hopkin University, published in book form, and to articles in recent dental literature by Howe, Grieves, Secombe, Gurley, and others (Refer to Index of Dental Literature).

VITAMINS

No one longer doubts the presence of *vitamins* in certain natural food stuffs nor their importance to life, growth and health. Vitamins are substances of unknown composition present in some natural foods in very small amount, and absolutely essential to the growth and health of animals and mankind. It is impossible to say at this time how many vitamins exist. The discovery of a vitamin requires the planning of a diet which is lacking in it, but which is complete in all other respects.

By means of feeding tests on animals, five vitamins have been discovered and for sake of convenience have been named A, B, C, D and E.

Sources.—*Vitamin A* is found in largest quantity in cod-liver oil, butter fat, egg fat and green, leafy vegetables. It is present in smaller amount in the embryo or germ of seeds, such as corn, wheat, barley, peas and beans. It is contained in small amount in beef fat, even less in lard and still less or none at all, in vegetable oils. It is absent, or present only in small amount, in artificial butter made from vegetables or animal oils.

The common foods which supply an adequate amount of the A vitamin are, therefore, milk, natural butter, eggs and green vegetables.

Vitamin B is most abundant in glandular organs such as liver and pancreas, and in egg yolks, green vegetables and the germ or embryo of seeds. It is also found in fruits, legumes, milk, potatoes, carrots and meat in much smaller amounts, while polished rice, white flour and bread, biscuit and cakes, sugar, butter and degerminated cereals are almost or entirely devoid of this growth factor.

Vitamin C is present abundantly in some fruit juices, particularly lemon and orange, in fresh green vegetables and in tomatoes. It is present in small amount in milk and meat and is not found at all in grains, cereals and most dried foods.

Vitamin D has only recently been discovered and is thought to exist in the same food substances as contain the A vitamin. Its richest source of supply is cod-liver oil. No food product approaches cod-liver oil in the richness of its A and D vitamins; even butter contains only a fraction of the amount present in cod-liver oil.

Vitamin E.—Recently researches of Evans and Bishop of the University of California have suggested the existence of another vitamin which is called E. It is associated with reproduction, and is found largely in the oil from the germ of wheat.

Results of Vitamin Deficient Diets.—*Vitamin A.*—When Vitamin A is removed from the food, failure of growth soon results accompanied eventually by loss of weight and emaciation. There is a lowering of body resistance to infection and increased susceptibility

FIG. 3.—Pigeon in paralytic or convulsive stage following a diet containing no B vitamin.

to disease. *Xerophthalmia*, a generalized inflammation of the eye leading to total blindness is the most striking result of a diet deficient in Vitamin A. (See Figs. 6, 7, 8 and 9.) Until the announcement of the discovery of Vitamin D, it has been thought that the A vitamin was concerned in regulating calcium and phosphorus metabolism and in the proper growth of bones and teeth. Whether it is always associated with the antirachitic vitamin in source and effect is still to be determined.

Vitamin B.—When this vitamin is absent, or insufficient in amount, the appetite is lost, food is not properly assimilated, there is diarrhea, loss in weight with emaciation, lowered metabolism, weakness, cardiovascular failure, and eventually paralysis and death. This disease is known as *beri-beri* and occurs frequently, particularly in the Orient, where the people make rice their main article of diet. Polished rice contains no B vitamin as this substance has been

removed, along with the germ and pericarp, from the rice grain in the milling process. During certain seasons, thousands of cases of beri-beri have occurred in the Philippines and in China and Japan. This disease can be prevented and usually cured by administering any substance rich in B vitamin.

FIG. 4.—Another view of same pigeon shown in preceding cut.

A similar condition can be produced in animals by feeding them a diet deficient in vitamin B. Pigeons fed on polished rice lose weight rapidly and in three or four weeks have convulsions and die. (See Figs. 3, 4 and 5.) Rats, dogs, monkeys, and other test animals, cannot grow or maintain their weight when they have every necessary

FIG. 5.—Same pigeon after administration of B vitamin. Picture taken on day following.

component of diet except the B vitamin. The addition of this vitamin to such a diet produces almost immediately increased appetite followed by growth and gain in weight.

The pathologic changes brought about by a lack of B vitamin in experimental animals are, in general, atrophic. The glandular organs such as ovary, testes, pancreas, liver and thymus show marked atrophy, the thyroid may show some congestion or slight atrophy, while the adrenals are always markedly hypertrophied, and the pituitary is somewhat enlarged in most cases. The heart shows dilatation and usually hydropericardium. There is hyperemia, congestion and echymoses, together with thinning of the walls of the gastrointestinal tract and frequently a marked colitis. In the later stages there is impairment of function of certain nerve cells of the brain and cord resulting in functional paralysis, followed by coma and death.

Vitamin C.—Absence of this factor in the diet results in the production of *scurvy*. The animal most susceptible to this disease is the guinea pig. Typical scorbutic lesions can be produced within two or three weeks. There is hemorrhage into the tissues, pain on motion, fragility and thinning of bones and sore gums with loose teeth. Monkeys are also susceptible to a scorbutic diet but do not show symptoms or signs of the disease for several weeks. Man requires a still longer time to develop this disease but the signs, symptoms and lesions in the three species are essentially the same. It has been fairly conclusively shown that it takes five times as much vitamin C for a child as it does for a guinea pig.

Cooking destroys vitamins, yet cooked foods may have adequate vitamin values. Professor Eddy of Columbia University, a widely known specialist on the subject of vitamins, cites as an example the studies some years ago which indicated that ordinary cooking temperatures in an open kettle destroys as much as 95 per cent. of the anti-scorbutic vitamin, or vitamin C. It was assumed, following these experiments, that cooked vegetables were entirely useless as a means of preventing scurvy and similar deficiency diseases. However, a test was later determined upon, and increased quantities of the cooked foods were fed to experimental guinea-pigs. It was discovered that even the small fraction of vitamin remaining in the cooked vegetables was sufficient to have the desired effect in the prevention of disease. This depends on the fact that vitamins are very powerful substances, and a little goes a long way. Further experiments with foods cooked in sealed containers under pressure, with air excluded, showed that the vitamin content was impaired much less than it was in open-kettle cooking.

Vitamin D.—This vitamin has not been extensively studied as yet. Its richest source is cod-liver oil and it is presumably found in

butter fat and green vegetables. Lack of it is said to be one of the chief causes of *rickets*. In the presence of a calcium-phosphorus imbalance and the absence of vitamin D proper calcification of the bones and teeth cannot take place. When added to diets, with such unbalanced mineral content, vitamin D in some manner promotes normal bone growth and calcification.

Vitamin D, as found in cod-liver oil in association with vitamin A, is a true specific in the prevention and treatment of rickets; and should play an important rôle in the treatment of periodontoclasia.

Vitamin E.—In the discovery of this vitamin, Evans and Bishop found that young rats can grow to maturity in an apparently normal manner when fed on certain diets, but upon which they never produce young. The animals are healthy looking, sexually active but evidently sterile. Further studies along this line are being carried on at this time.

The Need for Available Vitamin Preparations.—Many articles of diet, such as bread, pastries, certain cuts of meat, pasteurized milk, butter substitutes, some breakfast foods, rice, canned goods, pared potatoes, etc., are deficient, or in some cases wholly lacking, in one or more of the essential vitamins, and many of them do not supply the proper amount and kind of mineral salts.

Every patient coming into a physician's or dentist's office should have a record of his usual diet incorporated in his clinical history. This diet, item by item, is an important part in the daily life of every person and many illnesses and diseases can be traced to improper food and improper eating. Amenorrhea and sterility in animals can be produced at will by simple dietary changes. Exophthalmic goitre symptoms have been materially benefitted by removing fats from the diet and supplying vitamin A in concentrated form, the size of the goitre at the same time diminishing. That there is a close relation between the vitamin content of the food and the proper functioning of the endocrine system can no longer be doubted.

In cases of persons ill or convalescing from illness, it is usually impossible to load the stomach with sufficient amounts of vitamin bearing foods. In these cases, easily digested foods may be used to supply carbohydrate, fat and protein in adequate amount regardless of their vitamin content and the patient can be given the proper vitamins in concentrated form aside from the food. Such foods as are often given to these patients are not properly assimilated or utilized by the body in the absence of vitamins and are like so much waste material. To this class of patients vitamin concentrates are just as essential as any other medicinal agent. Such vitamin

products properly standardized, may be considered as therapeutic agents and not foods.

The other patients needing such concentrated vitamin preparations constitute by far the largest class. These are the infants and children.

THE DIET OF INFANTS

That breast milk is not always an ideal, complete and entirely adequate food for the infant can be easily proved. The quality of breast milk depends on the diet of the mother. When this diet is poor in any one of the vitamins, the milk is likewise deficient. Breast-fed infants can develop rickets (lack of A and D vitamins, calcium or phosphorus), beri-beri and failure to grow (lack of B vitamin) and scurvy (lack of C vitamin). All these diseases occur in breast-fed infants. The remedy in these cases is incorporation of the missing elements in the mother's dietary.

Bottle-fed babies consume cow's milk either as such or in some modified form. Fresh milk varies in its vitamin and mineral content according to the food eaten by the cow. If from cows fed on green pasture, then milk when perfectly fresh contains enough vitamins for growth and development. It may, however, be lacking in mineral content, as for instance iron and iodin, depending on the availability of these elements in the soil. In certain sections of the country iodin is almost absent and in these regions simple goitre in animals and man is prevalent. Winter milk from cows fed on dry food is comparatively poor in vitamins.

Fresh milk is not always available to babies, especially in cities. Pasteurizing milk serves as a protection against bacterial infection but at the same time tends to destroy some of its vitamin content. Milk which is allowed to stand and is heated and reheated before being fed to the infant loses further in vitamin value. It has been determined that it requires a pint (475.0 cc.) of absolutely fresh, summer milk to protect a child against scurvy. Many infants do not get such fresh milk and would therefore require a larger amount. Young infants on one-third or one-half milk mixtures cannot possibly consume one pint of milk and unless supplied with vitamin C from some other source, are getting less than the minimum amount of this vitamin required. It is not so much the cases of outspoken deficiency disease with which one has to deal in this country, as it is those who are getting not quite enough vitamin to make healthy normal children. These children are sub-normal or below par. They have less resistance to infection and less stamina.

Scurvy in both breast-fed and bottle-fed babies would be far more prevalent than it is, if vitamin C were not supplied in a concentrated form such as orange or lemon juice.

Rickets, either in the advanced or incipient stage, is a very common disease in this country. It is safe to say that 50 per cent. of the children under two years of age have rickets in some form. Many of these cases are never diagnosed. It is just as important that the antirachitic vitamin be used as a prophylactic for all young children as it is that the antiscorbutic vitamin be given them as is done at the present time in giving orange juice.

Defective bone formation and calcification and improper dentition are due in many cases to the lack of the antirachitic factors either in the mother's diet or in the child's food.

A small amount of vitamins daily will often mean the difference between an inadequate and an adequate diet—a difference between the maximum of good health and a condition just below par. Supplementing every child's diet with extra vitamins during the first years of life is a prophylactic measure which can do no harm and accomplish much good. "Prevention is better than cure."

Standards for Vitamin Preparations.—A physician would scarcely consider giving a tablet of calomel unless he knew how much calomel

FIG. 6.—Normal rat on complete artificial diet, containing A and B vitamins.

there was in it; nor would he prescribe a tincture of nux vomica unless he was assured that it contained a definite amount of strychnin. So with a vitamin containing product, it seems essential that the physician or dentist should know how much vitamin it contains.

While vitamins cannot at present be isolated and weighed, there are biologic methods of assay which determine in a relative manner the amount of vitamin contained in any food or any pharmaceutic preparation. In a brief manner some of these tests will be described.

Test for Vitamins A, B, C and D.—Young white rats weighing about 50 grams are fed a prepared diet consisting of the following purified substance:

Casein	18.0 Gm.
Salt Mixture	3.7 Gm.
Agar Agar	2.0 Gm.
Butter Fat	6.0 Gm.
Dry Yeast	5.0 Gm.
Starch	65.3 Gm.

This diet is sufficient for rats and an animal eating it will show a normal rate of growth. It contains adequate protein, fat, carbohydrate, salts and vitamins A and B. The growth curve plotted

FIG. 7.—Xerophthalmia in rat on a diet lacking A vitamin.

for a rat on this diet is used as a control for rats on diets being tested for their A or B content. If now the butter fat which contains the A vitamin is substituted by hydrogenated fat or some similar fat devoid of A, and young rats are placed on this A-free diet, they grow

FIG. 8.—A rat cured of xerophthalmia by addition of A vitamin to diet. Picture taken ten days later.

slowly for a week or two and then gradually decline in weight, get sore eyes and eventually die. (See Fig. 10, Nos. 1 and 3 on chart.)

If in place of butter fat some substance containing vitamin A is substituted, then the amount of A it contains can be determined by finding the least amount which given daily is sufficient to produce a

normal growth curve. This amount may be designated as one unit of vitamin A. (See Fig. 10, No. 2 on chart.)

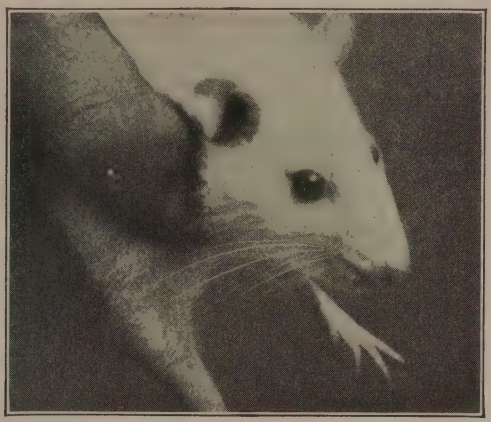

FIG. 9.—Showing normal eye of rat on artificial diet, containing both A and B vitamins.

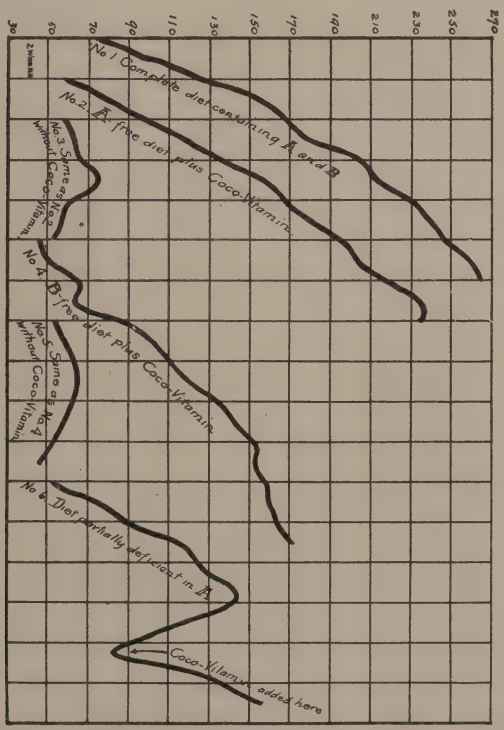
No. 1 Complete diet containing A and B
No. 2 A free diet plus Coco-Vitamin
No. 3 Same as No. 2 without Coco-Vitamin
No. 4 B free diet plus Coco-Vitamin
No. 5 Same as No. 4 without Coco-Vitamin
No. 6 Diet partially deficient in A
Coco-Vitamin added here

FIG. 10.—Growth of white rats, showing effect of A and B vitamins in the diet and lack of growth when either vitamin is deficient.

Similarly by substituting any B vitamin containing substance or preparation for the B vitamin as supplied by dry yeast in the above

diet its value can likewise be determined and the daily amount necessary to promote normal growth is taken as one unit of vitamin B. (See Fig. 10, No. 5 on chart.)

For the estimation or testing of the C vitamin, guinea pigs are used instead of rats, as the former are very susceptible to scurvy.

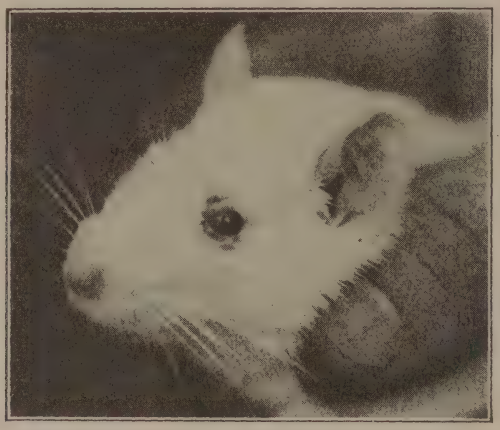

FIG. 11.—Early stage of xerophthalmia on A free diet.

These guinea pigs are fed on a diet of oats, bran, autoclaved milk and autoclaved hay. Such a diet contains no vitamin C and the animals show gross manifestations of scurvy usually within three weeks. The least amount of antiscorbutic substance, which added daily

FIG. 12.—Advanced stage due to lack of vitamin A.

to the above diet prevents scurvy for a period of at least 50 days, is taken as one unit of vitamin C. For milk this is almost 100.0 cc. per day, while for lemon juice about 2.0 cc. per day is sufficient. Lemon juice is, therefore, about fifty times as active as fresh milk as an

antiscorbutic; or in other words 10.0 cc. of lemon juice contains five units of C. whereas one pint (475.0 cc.) of fresh unpasteurized milk is required to furnish the same number of units.

The method proposed for testing vitamin D is to place rats on a standard diet with a low phosphorus and low vitamin A or D content, and to examine the bones after about six weeks for evidence of rickets. When decalcification of the ends of the long bones is shown in the control animals by histologic or *x*-ray examination, the remainder of the animals are given the D vitamin containing substance in varying amounts. The least amount which will produce definite evidence of a deposition of calcium at the epiphyseal line within five days may be taken as one unit of vitamin D. When the presence of the fourth vitamin (D) is fully confirmed, the number of units contained in various foods and preparations will be determined. For the present, it would seem best to simply estimate the antirachitic value of any product, regardless of its A or D vitamin content. There seems to be at least 300 units of the antirachitic substance in one ounce (30.0 cc.) of cod-liver oil.

STANDARDIZED VITAMIN PRODUCTS

Eli Lilly and Company was among the first to recognize the need for standardization of vitamin products if these new and important substances were to take their proper place in medicine. For several years, its Research Laboratories have been testing many sources and preparations of vitamins. It was finally decided to adopt vitamin units for each vitamin and to state the number of such units on all vitamin products.

Bearing in mind the fact that many children in this country are really suffering from an inadequate supply of certain vitamins in their daily food, a pleasant tasting liquid chocolate preparation suitable for children and containing both the A and B vitamins was placed on the market. This is called Coco-Vitamin. A little later, in order to meet a demand for a preparation in capsule form, a dry powder was also supplied and given the name Alpha-Betamin, indicating a combination of the A and B vitamins.

Coco-Vitamin.—As stated on the label of each bottle of Coco-Vitamin, it contains not less than 16 units of B and 240 units of A to each fluid ounce (30.0 cc.).

Coco-Vitamin is a concentrated vitamin product. One ounce of it is equal in B vitamin to about ten ounces of milk and in A vitamin to more than one pound of fresh spinach or other green vegetable.

It is so palatable that children will take it and ask for more. It contains 40 per cent. of vitamin-tested cod-liver oil, but so well disguised is this oil as to be scarcely detectable. It contains 40 per cent. of vitamin B extracts and 10 per cent. of malt extract. It is more than a mere vitamin preparation—it is, in addition, a nutritious tonic. Recent investigations have tended to show that the high value of cod-liver oil in the prevention and treatment of rickets is due to a fourth vitamin—designated as vitamin D. Since cod-liver oil is the richest source of this antirachitic factor, Coco-Vitamin can truly be said to be a prophylactic and specific treatment for this disease.

An authority on dietetics and on food deficiency diseases has recently stated that over half the children under two years of age have rickets in some stage, either incipient, mild or advanced. It is just as necessary, therefore, that an antirachitic be given to infants and children as it is to give them an antiscorbutic as is now so universally done by the use of orange juice. Cod-liver oil is the best antirachitic known, but cod-liver oil is distasteful to many, so that a palatable product such as Coco-Vitamin, also supplying the B vitamin, is much to be preferred.

Dose of Coco-Vitamin.—For small infants a dose of ¼ to ½ teaspoonful given with each feeding (may be given alone or in the milk). For older children 1 to 3 teaspoonfuls three times a day after meals. For adults, 1 or 2 tablespoonfuls three times a day after meals.

Most children and adults will like Coco-Vitamin as it is. If in any case it does not prove agreeable to the taste, it may be given in one or two ounces of milk, with which it blends perfectly. It is also miscible with water. After the bottle has been opened it should be kept in a refrigerator or other cool place.

Pulvules Alpha-Betamin.—These pulvules are filled capsules, containing both the A and B vitamins. Each capsule has 4 units of B and 16 units of A. For small children or those who cannot swallow capsules, the material may be emptied out and taken in milk, soup or with cereal or other foods.

Alpha-Betamin is indicated in those cases, where for some reason the diet is restricted and is lacking in sufficient vitamin content. Patients with chronic kidney disease, diabetes, gastrointestinal disturbances, tuberculosis and other debilitating conditions continue on a monotonous diet for long periods of time and this diet is very apt to be lacking in these new-found essential food factors and also quite often lacking in certain needed mineral salts. Crackers and

"beef tea" will not support life in the lower animals and there is no reason to think this an ideal diet for mankind.

Of greatest importance are these vitamins during pregnancy and the period of lactation. It is during this time that there is an extra strain on metabolic processes, a need for increased food and increased vitamin intake. The decalcification of bones (osteomalacia) and dental caries occurring not uncommonly in pregnant women are a result of faulty metabolism due primarily to improperly constituted food.

During the nursing period the child grows rapidly, teeth are being formed and bones calcified. Insufficient diet for the mother means insufficient and inadequate food for the infant. Scurvy, rickets, beri-beri, and malnutrition may and do occur in children, exclusively breast-fed.

In this country the great importance of vitamins is their value in prophylaxis. Outspoken deficiency diseases are rather rare, but conditions of malnutrition are common both in adults and in children.

Alpha-Betamin can be used to advantage in many cases where there is a need to supplement the daily vitamin intake. Poor appetite, loss of weight and general lassitude may not be due in all cases to a lack of vitamins, but a lack of vitamins can cause such symptoms and the amount of vitamins in the diet should be taken into consideration in making a diagnosis and prescribing treatment.

Dose.—For infants or small children the contents of 3 Pulvules Alpha-Betamin daily, given with the food. For adults 2 Pulvules three times a day. Keep package tightly closed when not in use.

ENDOCRINOLOGY

The subject of *endocrinology*—a study of the glands of internal secretion, is attracting attention by certain members of the dental profession; and that part of the general subject which relates to the teeth is known as *endocrinodontia*. The opinions regarding the value of gland products in internal medicine are many and varied; and their use in dental practice is even more unsettled. No attempt will be made to discuss the subject here; but attention is directed to the statement of Sajous[1] of the relation of certain secretions—adrenalin and adrenoxidase, to vitamin C which the author claims contains tyrosin and tyrosinase. "In plant life, tyrosin corresponds with the constituent of hemoglobin which causes it to become converted into

[1] Dental Cosmos, Vol. XXV, No. 7, p. 710.

oxyhemoglobin. The vitamin C value of a plant, therefore, is represented by its tyrosin content and it becomes red in proportion." The turnip, for example, is rich in vitamin C—contains tyrosin and is correspondingly red in color. It is known that the absence of vitamin B from the diet causes the thymus gland to atrophy. It undergoes regeneration when this accessory food factor is provided to pigeons previously deprived of it. Experimental work in dietary deficiencies show that the thymus may be in a measure a storehouse for vitamins. Howe, Grieves and other dental investigators are working along these lines and it is hoped that their efforts will soon throw much light on these important subjects.

It has been approximately twenty years since an extract of the pituitary or hypophysis gland was first used as a therapeutic agent, but only during the last ten or twelve years has it come into extensive use. At present it ranks with thyroid, adrenal and pancreas extracts as the most used of the many gland extracts; but even so, its chemic composition or identity is unknown and its pharmacologic action not fully understood.

During the past several years Research Laboratories have been engaged in the production of pituitary extracts. From time to time important developments in improving the product have been made, until at the present time there is on the market an extract which contains the active principle of the posterior lobe of the pituitary gland in a state of purity not heretofore attained on a commercial scale, and in such form that it can be sterilized by heat and will maintain its activity over long periods of time. Simultaneously by modification of previously known methods a method has been perfected for testing the activity and bringing each lot to the same standard of strength.

The physician in prescribing pituitary extract, can now be assured of obtaining a product which is uniform in strength, low in total solids and nitrogen content, and whose activity is retained over a long period.

The most important effect of the injection of this glandular hormone or principle is exerted on smooth muscle structures causing them to contract. In this way it induces rise in blood pressure, contraction of the pregnant uterus at term, initiation or increase of intestinal peristalsis and emptying of the urinary bladder.

Pituitary extract has been advocated for many purposes and in many different diseases. Its efficacy is now well established in the following conditions: *Child-birth, intestinal paresis, surgical shock* and *diabetes incipidus.*

REMEDIES OTHER THAN DRUGS

The object sought in all therapeutics is simply to assist Nature in her efforts to ward off disease and to restore an abnormal to a normal condition. In dental therapeutics this gives to the resourceful dentist a wide range of activity. There are several means of combating disease other than by the use of drugs. Those deserving mention will briefly be discussed here. They are:

Heat.	Electricity.
Cold.	Massage.
Compressed Air.	Suction.
Light.	Suggestion.

HEAT

Heat is a useful therapeutic agent. It is largely employed locally in dentistry, and is utilized in both the dry and moist forms. Dry heat is applied by means of hot cloths, bran-bags, water-bags or water-bottles, or superheated dry air. Moist heat may be applied by means of fomentations, poultices, or the hot-water syringe. Hot-water baths are also applicable to certain limited portions of the body, as the feet, and are used for counterirritant purposes. Locally applied, heat allays irritation of the peripheral sensory nerves, dilates the cutaneous vessels, increases perspiration, and, like cold and counterirritation, doubtless exerts a favorable influence on the subjacent structures.

The general application of heat may be obtained by means of the hot-water bath, hot pack, hot-vapor bath, or hot blankets. In the Russian bath steam replaces the hot-dry air of the Turkish bath. The first effect of the general application of heat is free perspiration from dilatation of the cutaneous vessels.

Moist external heat is used for a variety of diseases, especially *subacute* and *chronic rheumatism*. Dry external heat may be employed in many cases of *drug poisoning*, one symptom of which is the characteristic cold, clammy sweat.

Moist heat is used locally in *pericementitis*, *in acute alveolar abscesses* accompanied by pain and swelling, and many other dental conditions. Dry heat is chiefly used in dentistry for *drying tooth-structure* and *obtunding sensitive dentin*. For this purpose many apparatuses have been devised for heating dry air. For root-canal work properly-shaped wire may be heated and used.

Heat is also employed to the extent of actual destruction of tissue in *vesication* and *cauterization*. The thermocautery and galvano-

cautery are exceedingly valuable as counterirritant, revulsive, and hemostatic measures.

Thermometric Scale.—For determining the temperature, the Fahrenheit scale is in ordinary use in America and England; the Centigrade is used on the European Continent; the latter scale is also largely used in the sciences. The freezing-point of water with the Fahrenheit scale is 32° above zero; with the Centigrade scale it is at zero. The boiling point of water with the Fahrenheit scale is 212°. This minus the 32° equals 180° above zero. The boiling-point of water with the Centigrade scale is 100°. Therefore, stated in terms of proportion: 100°C.:180°F.::5:9, hence the following simple rules for converting the degrees of one scale into the other.

To Convert Degrees of the Fahrenheit Scale into those of Centigrade: If the temperature be above the freezing-point (32°), subtract 32; if it be below the freezing-point, subtract the number from 32, algebraically; then multiply the remainder by 5 and divide by 9.

To Convert Degrees of the Centigrade Scale into those of Fahrenheit: Multiply the number of the former by 9 and divide by 5; if the temperature be above the freezing-point (0°), add 32; if it be below the freezing-point, subtract the result from 32, algebraically.

COLD

Cold, like heat, may be used either locally or generally as a therapeutic agent. It is the local application of the remedy with which dentists are mostly concerned. It may be locally applied by means of cloths wrung out of iced water, an ice-bag, an ice-poultice, etc. As cold is but a lesser degree of heat, the latter may be abstracted and cold produced by spraying the part with a highly volatile liquid, like ethyl chlorid, ether, etc.

Local applications of cold abstract heat from the part, lessen the sensibility of the peripheral nerve-endings, cause constriction of the blood-vessels traversing the tissues exposed to the cold, and affect, reflexly, the vascularity of the structures subjacent to the site of application.

The general application of cold to the body may be accomplished in several ways: By a cold-water bath, cold sponge-bath, cold pack, or the cold douche. When followed by vigorous rubbing with a Turkish towel, cold bathing exerts a powerful tonic effect. It sharpens the appetite, aids digestion, promotes metabolism, and greatly favors the elimination of waste products.

Cold is employed for a variety of purposes in the treatment of disease. In dentistry it is used as a counterirritant in *acute alveolar*

abscess, in *pericementitis*, *neuralgia*, and other conditions. As a refrigerant local anesthetic, the effect of cold may be obtained by using ether, combinations containing it, or ethyl chlorid, as a spray. In this manner cold is used in *lancing abscesses*, *obtunding sensitive dentin*, *extracting loose teeth*, *etc.*

COMPRESSED AIR

Compressed air is one of the most convenient agents in the modern dental office. While in itself it may not be considered a therapeutic agent, except as a vehicle for applying heat or cold, it is, nevertheless, a valuable adjunct to the use of many such agents. For *drying a sensitive cavity*, *clearing away the "chips,"* and *lessening the pain of drilling*, it has no equal (see p. 332). In *treating periodontoclasia* it serves a useful purpose. By its employment the pocket may be kept dry sufficiently long for the operator to see in many cases whether or not the deposits have been thoroughly removed. It may be used as the force for spraying solutions all through the operation; and when the teeth are scaled and polished the field may be kept dry by the use of compressed air while the astringent remedy is applied. The resourceful dentist will find many uses for this agent.

LIGHT

Light is a form of energy which has recently been brought forth as having a peculiarly favorable effect upon diseased tissues of the body, and is employed to-day for a variety of purposes in therapeutics, both general and dental. The blue light, lucodescent light, and other forms are used. The mode of action is not well understood. Extravagant claims are being made for the lucodescent light, but it is thought by many that its real virtue lies in the soft penetrating heat produced. It may prove to be a practical means of applying heat, which has long been recognized as a therapeutic agent. Reliable evidence has thus far been lacking to prove that light has an action upon the tissues other than through the heat generated. The blue light has been suggested for *obtunding sensitive dentin*, and is obtained in one way by passing the ray through blue glass. A blue bulb (16 or 32 c.p.) is used on an ordinary electric socket. The room is darkened and the patient requested to look at the light which is held from 6 in. to 1 ft. from the eyes. Whether the light acts locally or affects the vision and thus the general nervous system has yet to be determined. The author's experience with light thus far has not been encouraging. It is true, however, that light differs in effect

from heat, though both come from the same heated body. This phenomenon is observed in the action of light on certain chemicals; for example, the silver salts undergo a chemic change when exposed to sunlight or luminously hot bodies. For this reason Black and others have suggested that the tooth-surface treated with silver nitrate be exposed to the sunlight, if possible. The author finds a more practical way of accomplishing the change in the decomposition of the salt by using the small electric mouth-lamp. Light from a small electric mouth-lamp serves almost as a positive means of diagnosing a *dead pulp* in a tooth where the color is practically normal; it also aids materially in confirming the diagnosis of *obscure antrum involvement.*

Carrel, Crile, and others, advocated the use of light or heat from an electric lamp in the treatment of *infected wounds.* It is to be hoped that further investigation may be made with light as a therapeutic agent that its action may be better understood, for it seems to possess sufficient merit to justify such investigation.

Röentgen or x-ray.—The Röentgen or *x*-ray has been employed extensively in both general and dental therapeutics; in dentistry it is largely used for diagnostic purposes. By means of the *radiogram* (an *x*-ray picture) the diagnosis of the following conditions may be confirmed:

1. *Fracture of the jaw* and the relation of the fragments.
2. *Fracture and dislocation of the teeth* in the jaw.
3. *Alveolar abscess:* involving more roots than one; in relation to the nasal cavity; in relation to the maxillary antrum (antrum of Highmore).
4. *Impacted and nonerupted teeth;* the cause of neuralgic conditions, and in point of treatment, extraction, etc.
5. *Pulp-nodules, pulp-calcification, and secondary dentin.*
6. *Cementosis.*
7. *Foreign bodies in the maxillary antrum.*
8. *Broken broach in tooth-root.*

There are other conditions in dental practice wherein the *x*-ray aids materially in arriving at a correct diagnosis. Much credit is due to Kells, Price, Shamburg, Lewis, Raper, McCoy, Simpson, MacCormack, and others for developing radiography in dentistry.

The *x*-ray treatment has been found extremely valuable in *superficial cancer, lupus vulgaris,* and *acne.* It has also been employed in the treatment of *periodontoclasia* with varying results. The powerful actinic properties of this modified form of light are illustrated by the fact that several deaths and many injuries, such as burns,

necessitating amputation in some cases, have been traced to long-continued exposure to the *x*-ray.

The method devised by Finsen of concentrating rays of either sunlight or electric arc-light has met with more or less success in the treatment of *lupus vulgaris* and other skin diseases, but it has not been utilized in dentistry to any extent.

Radium.—The salts of radium (bromid and chlorid) give out three kinds of rays, known as *alpha*, *beta*, and *gamma* rays. The therapeutic uses of radium rays have been shown to follow practically the same lines as those of the *x*-ray, but they are generally considered less useful. At the present time the use of radium rays is only in the experimental stage and no positive evidence is at hand to prove their superior value. They require the same careful handling as the *x*-ray, as they are capable of producing severe burns and even deep-seated ulcers.

ELECTRICITY

Electricity is used as a therapeutic agent in itself, as well as a carrying medium for drugs (cataphoresis), and for purposes of diagnosis and prognosis. Two currents are employed, the *primary*, or *galvanic*, and the *induced*, or *faradic*, the battery furnishing the current being supplied with a *positive* pole, or *anode*, and a *negative* pole, or *cathode*. When the electric current is passed through a muscle it causes contraction of the latter. As a muscle degenerates it gradually loses its electrocontractility, the response to the faradic current disappearing first, while the galvanic current produces contraction for some time longer, until finally no current will produce any effect.

Electricity is used as a muscle and nerve stimulant for a variety of conditions, such as the so-called idiopathic forms of *neuralgia*, in *neurasthenia*, *hysteria*, etc. In *poisoning by opium and other narcotics* a strong faradic current often affords a means of arousing the patient without increasing the exhaustion or causing any ill effects. Electricity affords almost a positive means of diagnosing a *dead pulp* in a tooth. The suspected tooth is tested by using a dry-cell vibrating coil, which will be explained in Practical Therapeutics (see p. 397). In dental therapeutics, perhaps, the greatest use of electricity has been in connection with a method of treatment called *cataphoresis* and *ionization*.

Cataphoresis.—This is a term applied to the process of carrying medicinal agents in solution into the various tissues and organs of the body by means of the electric current. It is used chiefly for *obtunding sensitive dentin* and for the purpose of *anesthetizing the pulp* to

facilitate its painless removal (see p. 373). **Ionization** has been elsewhere discussed.

MASSAGE

Massage is a term used to designate methodical kneading, rubbing, and percussion of the body. The person practising massage is known as a *masseur* (male) or *masseuse* (female). The efficacy of proper massage in many pathologic conditions can no longer be doubted. It acts as a stimulant to both nerve and muscle and to many of the bodily functions, assisting circulation and favoring the elimination of waste-products. Massage is employed in dentistry for both its local and systemic effects in *neuralgia*, *periodontoclasia*, and *edema resulting from alveolar abscess* and other conditions; in medicine it is used in *rheumatism*, *paralysis*, *synovitis*, *sprains*, and *fractures*. In the "rest cure" of Mitchell it is combined with isolation, rest, forced feeding, and faradism. It is also used for its general effect in *neurasthenia*, *nervous prostration*, and *hysteria*.

SUCTION

The method of producing hyperemia in a part by means of **suction** for the purpose of combating disease is fast gaining recognition in medicine, and it has been employed also, to some extent, in dentistry.

When some noxious influence acts on a more or less limited area of the body, local resistance is manifested by the production of granulation tissue and of hyperemia. Under favorable circumstances the granulation tissue repairs defects resulting from the noxa, or more or less completely encapsulates the irritating agent. Under less favorable circumstances, the irritation being continuous *e.g.*, in tuberculous infection, granulomata are formed, these granulomata being evidence of defense. If the resisting power is sufficient, the embryonic tissue overcomes the irritant and incloses it in fully developed scar tissue. Stimulation of the production of granulation in and around a tuberculous focus seems to be the therapeutic action of injections of emulsions containing iodoform, bismuth, finely divided carbon, etc., and of sclerogenic injections.

The second method by which Nature resists a noxa (or infection) is by hyperemia. When an irritant, *e.g.*, the staphylococcus, gains access to the tissues, the flow of blood to the part becomes increased, there is exudation of fluids and leucocytes from the vessels into the tissues. The blood serum contains *antibodies* or *antitoxins* which

neutralize the chemic products of bacterial activity; bacterial agents which attack the bacteria themselves; opsonins which prepare the bacteria for absorption and destruction by phagocytes, or perhaps act as a sort of appetizer to the phagocytes, and lastly there are the leucocytes which act as phagocytes, directly killing bacteria or, as scavengers, removing the débris of the fight. Thus, while the granulation tissue acts as a sort of passive rôle besieging the invading irritant, the hyperemia directly and actively combats it (Binnie).[1]

The suction method of producing hyperemia cannot but prove efficacious in the treatment of certain forms of *alveolar abscess* and *periodontoclasia*. It now remains for some ingenious dentist to devise a practical appliance by which dental applications can be made, and much good will surely result from this method of assisting nature in her efforts to restore an abnormal to a normal condition. Keefe has applied suction in the treatment of *periodontoclasia* with good results by taking an impression in wax, removing and cutting the wax from around the imprints of the teeth, thus creating a space from which, after reinserting the impression, the air can be withdrawn by means of a large bulb or syringe attached to a tube leading through the impression tray and into the space. Other apparatuses for the purpose have also been suggested.

The former application of the *leech*, called *leeching*, was somewhat on this same principle, but the practice, especially in dental therapeutics, is gradually becoming obsolete.

SUGGESTION

Suggestion, as used in therapeutics, is the method of employing *faith* or *confidence* in the treatment of disease. There is no doubt that faith is one of the oldest therapeutic agents known. Guerini[2] refers to the confidence placed in ancient times in the power of the priests to cure the sick, and relates how, to maintain this confidence, the latter gradually resorted to the administration of infusions and decoctions made from fresh herbs, etc. With all peoples, from the earliest centuries to the present day, suggestion has ever been active. Where the disease is purely functional, and not organic, the influence which the mind can be made to exert over the body is a potent factor in the treatment of the condition, whether this influence be called *psychotherapy*, *mental-healing*, *Christian Science*, or by some other name.

[1] Journal of the American Medical Association.
[2] History of Dentistry.

Hypnotism is practised by many dentists as a means of preventing pain and controlling patients. Confidence is an important factor in dental practice. The dentist should ever strive to win the confidence of his patients, be they young or old, and when obtained he should constantly guard against abusing it by careless and indifferent methods of operating.

METROLOGY

Metrology is the science that treats of the gravitating force of a body, called *weight;* its extension, bulk, or volume, called *measure,* and the relation of these to each other, called *specific gravity.*

In pharmacy, liquids, as a rule, are measured, while solids are weighed; however, certain liquids are required to be weighed. The difference between measuring and weighing some liquids is not great, while with others it is considerable, and if this difference is not considered, varying results frequently follow. This, of course, is due to the different specific gravity of the liquids (*e.g.*, chloroform is heavy while alcohol is light).

The systems of weight in the United States are Avoirdupois and Apothecaries', or Troy.

The United States Pharmacopeia, in all of its editions previous to 1880, adopted the apothecaries' weight as the official standard. In 1880 the *parts-by-weight system* was adopted. During the ten years of its official life this system never became popular, owing to the difficulty of having to weigh all liquids, regardless of their specific gravity. However, its adoption at this time paved the way for the adoption of the *Metric System* in 1890, and again in the eighth ninth and tenth decennial revisions of the U.S.P., in 1900, 1910 and 1920. The metric system, therefore, is now the official standard. Nevertheless, although not officially sanctioned, the apothecaries' weight still remains in common use in prescribing medicines, owing to the ease with which it can be subdivided into simple fractions. Throughout this work the apothecaries' weight has been given the preference, the metric equivalent being enclosed in parenthesis. One troy ounce, equal to 480 grains, is easily divided by any even number—2, 4, 8, etc. This quality is of great practical value to the dispenser and prescriber alike. For the latter it simplifies prescription-writing because of its easy division; the quantity of a remedy required for administration may be computed with the measure of the solvent very quickly in simple fractions.

The fluid measure used in pharmacy can always be reduced to drams—the equivalent of a teaspoonful. This being the measure ordinarily used in administering medicines, the quantity of a dose is

readily ascertained. When, for example, 30 grains of potassium iodid in one fluidounce of compound syrup of sarsaparilla is prescribed, with directions "one teaspoonful at a dose," it is readily computed that the quantity of potassium iodid in each dose must be 3¾ gr., since one fluidounce contains eight fluidrams, or teaspoonfuls. The tables for the various systems of weights and measures are here given:

Troy, or Apothecaries' Weight

20 grains (gr.)	= 1 scruple	(℈)	=	20 grains.
3 scruples	= 1 dram	(ʒ)	=	60 grains.
8 drams	= 1 ounce	(℥)	=	480 grains.
12 ounces	= 1 pound	(℔.)	=	5,760 grains.

Wine, or Apothecaries' Measure

60 minims (♏)	= 1 fluidram	(f ʒ).
8 fluidrams	= 1 fluidounce	(f ℥).
16 fluidounces	= 1 pint	(O).
2 pints	= 1 quart	(qt.).
4 quarts	= 1 gallon (Cong., C.)	= 231 cubic inches.

A fluidounce of water at its maximum density (4°C.) weighs 456.37 grains.

Avoirdupois Weight

1 ounce (av. oz.)	= 437.5 grains.
16 ounces	= 1 av. ℔.
1 pound	= 7,000 grains.

The odd number of grains in the avoirdupois ounce, as compared with the round, easily divided number of grains of the apothecaries' ounce, is due to the fact that in the latter system the *unit* is the ounce, and from this the pound was formed. In the former the pound is the *unit*, which divided by 16 gives an ounce containing only 437.5 grains, as against 480 grains in the apothecaries' ounce.

The troy or apothecaries' weight is used in the compounding of prescriptions; the wine or apothecaries' measure is used for measuring liquids in pharmaceutic work, and the avoirdupois weight is in common use generally. The troy and avoirdupois *pounds* are abbreviated in the same manner, ℔., but differ in the number of grains contained (5,760, 7,000). The troy pound is rarely used, and the use of the scruple (℈) is practically obsolete; it is just as convenient to write for 20 grains, and there is less likelihood of a mistake, for the abbreviation for scruple may be taken for a carelessly written dram mark.

Approximate Fluid Measures

Teaspoonful	= f℥j
Dessertspoonful	= f℥ij
Tablespoonful	= f℥iv
Wineglassful	= f℥ij
Teacupful	= f℥iv

One cubic inch of distilled water, at its maximum density, a temperature of 4°C. *in vacuo*, weighs 252.892 gr., and 231 cubic inches is a measure equivalent to the U. S. gallon. The *gallon* is divided into 8 pints; 1 *pint* into 16 fluidounces; 1 *fluidounce* into 8 fluidrams, and 1 *fluidram* into 60 *minims*. The measure of volume may, therefore, always be compared with the weight of water as above, the standard for comparison, thus:

One cubic inch = 252.892; 252.892 × 231 = 58,418 gr. = 1 gallon.
58,418 ÷ 8 = 7,302 grains = 1 pint.
7,302 ÷ 16 = 456.37 grains = 1 fluidounce.
456.37 ÷ 480 = 0.95 grains = 1 minim.

For all practical purposes a minim may be considered the equivalent of a grain (1 min. = 0.95 gr.). A *drop* is not a minim, although generally considered its equivalent, and the measurement of liquids by drops does not give uniform and accurate results. The size of drops varies greatly with different liquids; also with the same liquids, according to the conditions governing the process of dropping. Among these conditions may be mentioned:

1. The quantity of the liquid contained in the vessel.
2. The size and shape of the lip of the vessel.
3. The rapidity of the dropping.
4. The temperature and character of the liquid.

THE METRIC SYSTEM

The metric system of weights and measures was first introduced in France at the close of the eighteenth century; hence it is often called the French system. Owing to its decimal parts, it is frequently termed also the *decimal* system. This system has gradually displaced all the various systems of weights and measures throughout the European continent, and is the only recognized system in all countries except Russia, Great Britain and her colonies, and the United States of America. For this reason the metric equivalent has been given for quantities throughout this work

Hallberg states that because of its simplicity in construction, regularity and convenience in exact calculations, it has become the only system for scientific

work, and is no doubt destined to soon displace the older systems in art and commerce throughout the civilized world. Through our system of decimal numbering—ones, tens, hundreds, thousands, etc.—the *monetary* systems of all civilized nations, except Great Britain, have also become decimal and brought with them the metric system.

The functions of money and weights and measures are so intimately related and interdependent that a decimal system in one practically demands a decimal system in the other. The decimal system of money was one of the privileges accorded the people of the United States by early adoption, but while adopting this great improvement over the old English pound, shilling, and pence, the old English weights and measures, based on the penny-system, were unfortunately retained.

Although the U. S. Government, in 1867, made the metric system obligatory in the three branches of its medical service—the Army, Navy, and Marine Hospital—and also legally permissible throughout the Union, all efforts to make it obligatory in the various States have so far failed. It is difficult to change a long-established custom, but it does seem that there is little excuse for not adopting the metric system generally in the United States with our decimal proportions of the *dollar*, the *dime*, and the *cent*, based upon exactly the same principle.

The metric system is based upon the *meter*, which is the standard *unit* of *linear measure*, being the ten-millionth part of one-fourth of the circumference of the earth (the quadrant). It is, therefore, the one forty-millionth part of the entire circumference of the earth taken around the poles, measured by a *meridian* and not by the *equator*.

One *meter* is equal to 39.37 inches.

The *liter* is the *unit* of *liquid measure*, and is the cube of one-tenth of the meter, or cubic decimeter, and one-thousandth part of it, or the cube of one-hundredth of the meter, is *one cubic centimeter*. The term "cubic centimeter" was replaced in the U.S.P. IX by the word "mil." The United States Bureau of Standards declared that the term cubic centimeter was a misnomer, there being a slight difference between the thousandth part of a liter and the cubic centimeter, as 1 liter was determined to be equivalent to 1.000027 cubic decimeters. The Committee of Revision for the U.S.P. IX decided that the time had come to adopt the word mil, the first three letters of the whole word "milliliter." This, however, did not prove satisfactory and the Committee of Revision for the U.S.P. X decided to return to the almost universally used term "cubic centimeter," abbreviated cc. It is understood that the cubic centimeter represents the one-thousandth part of a liter. In this Edition, therefore, the author is pleased to return to and use the abbreviation "cc." instead of the abbreviation "mil."

The *unit* of *weight* is the *gramme* or *gram*, the weight of 1 milliliter of pure water *in vacuo* at its maximum density, and is equivalent to 15.432 grains.

The *unit gram* (written with a period immediately following, thus, 1.) is divided or multiplied to express smaller or larger denominational quantities, respectively, by simply moving the decimal point to the left or to the right. This illustrates the simplicity of the entire system.

To designate the quantities thus obtained, *Latin* prefixes are used to describe those less than one gram, and *Greek* those larger than one gram—the former being written with a small letter, the latter with a capital letter.

Metric Weights

1 myriagram	(Mg.)	= 10,000 grams.
1 kilogram	(Kg.)	= 1,000 grams.
1 hectogram	(Hg.)	= 100 grams.
1 decagram	(Dg.)	= 10 grams.
1 gram	(Gm.)	= weight of 1 cc. of water at 4°C. (unit).
1 decigram	(dg.)	= 0.1 gram.
1 centigram	(cg.)	= 0.01 gram.
1 milligram.	(mg.)	= 0.001 gram.

Metric Measures of Capacity.

1 myrialiter	(Ml.)	= 10,000,000 cubic centimeter.
1 kiloliter	(Kl.)	= 1,000,000 cubic centimeter.
1 hectoliter	(Hl.)	= 100,000 cubic centimeter.
1 decaliter	(Dl.)	= 10,000 cubic centimeter.
1 liter	(L.)	= 1,000 cubic centimeter (unit).
1 deciliter	(dl.)	= 100 cubic centimeter.
1 centiliter	(cl.)	= 10 cubic centimeter.
1 milliliter	(ml.)	= 1 cubic centimeter.

Equivalents to the English Weights and Measures.—Various methods have been proposed for adapting the metric weights to our apothecaries' weights used in prescription-writing without entailing calculations in fractions, as the exact equivalent would necessarily do. The method of accepting 32.0 grams as equivalent to one troy ounce and 30.0 cc. as equal to one fluidounce seems to be the least objectionable.

To convert avoirdupois or troy into metric weights, the equivalent of the gram in grains—15.432—should be remembered, as it serves the purpose of a basis for obtaining the equivalent of all the higher denominations. It will be observed that this number is composed of the first five numerals in reversed order, except the figure 1. For

all practical purposes the fraction may be dropped, and 1.0 Gm. may be said to equal 15 gr.

The *Liter* is equivalent to 34 fluidounces (approximately 1 quart); half a Liter, therefore, approximates 1 pt., and is sometimes called a *metric pint* (17 fl. oz.).

The *Meter* is equivalent to nearly 40 inches, from which the divisions may easily be rendered as follows: 1 decimeter, dm, 4 in.; 1 centimeter, cm., 0.4 in.; 1 millimeter, mm., 0.04 ($\frac{1}{25}$) inch.

Hallberg sums up the advantages of the metric system as follows:

1. Simplicity of construction, abolishing complex tables.
2. Uniformity, through its adoption in all scientific work.
3. Permanency and stability of its standard unit derived from the earth itself.
4. Facility of its multiplication and division by decimal points.
5. Commensurability of all its units and denominations in *weight, volume, linear* measures, and our system of *money*.

Equivalents of Apothecaries' in Metric Weights

Grain.		*Gram.*	*Grain.*		*Gram.*
$\frac{1}{200}$	=	.000324	$\frac{1}{2}$	=	.0324
$\frac{1}{150}$	=	.00043	1	=	.0648
$\frac{1}{100}$	=	.00064	2	=	.1296
$\frac{1}{75}$	=	.00086	5	=	.3240
$\frac{1}{50}$	=	.00129	8	=	.5184
$\frac{1}{40}$	=	.00162	10	=	.6480
$\frac{1}{20}$	=	.00324	15	=	.9720 (approx. 1.0 Gm.)
$\frac{1}{10}$	=	.00648	20	=	1.2960
$\frac{1}{6}$	=	.0108	30	=	1.9440 (approx. 2.0 Gm.)
$\frac{1}{4}$	=	.0162	40	=	2.5920
$\frac{1}{3}$	=	.0216	60	=	3.888 (approx. 4.0 Gm.)

Equivalents of Apothecaries' in Metric Measures of Capacity

Minims.		*Cubic centimeters.*	*Fluidounces.*		*Cubic centimeters.*
1	=	0.061	1	=	29.57 (approx. 30.0 cc.)
2	=	0.123	2	=	59.14
3	=	0.185	3	=	89.00
5	=	0.308	4	=	118.29
7	=	0.431	6	=	177.42
10	=	0.616	10	=	295.73
15	=	0.924 (approx. 1.0 cc.)	12	=	355.00
20	=	1.23	16	=	473.17 (approx. ½ L.)
30	=	1.84 (approx. 2.0 cc.)	20	=	591.50
40	=	2.46	24	=	710.00
60	=	3.7 (approx. 4.0 cc.)	32	=	946.35 (approx. 1 L.)

PERCENTAGE IN SOLUTIONS

To estimate the quantity of a drug required to make a certain volume of a solution of a given percentage, *divide* the weight of the volume of the liquid to be used as the solvent by 100, and *multiply* by the percentage. Thus, in an ounce of a 10 per cent. *aqueous* solution of silver nitrate there are 45.6 grains of the salt.

100 per cent. = 456.37 gr. (weight of a fl. oz. of water).
1 per cent. = $\frac{1}{100}$ of 456.37, or 4.56 gr.
10 per cent. = 10 × 4.56, or 45.6 gr.

Therefore, it is well to remember that 4.56 gr. or, approximately, 4.5 gr. of any drug added to a fluidounce of water makes a 1 per cent. solution of the drug. The amount of a drug necessary for any quantity of any per cent. solution may be ascertained by *multiplying* the quantity by the percentage, and the product by 4.5. Thus, to ascertain the amount of cocain hydrochlorid or any other drug required to make two ounces of a 1.5 per cent. solution, we would *multiply* 2 × 1.5 × 4.5 = 13.5 gr. Where there is a fraction of a grain in the ultimate result it is best to drop it if less than one-half, or raise it to one if over one-half.

To determine the weight of a fluidounce of a liquid other than water, *multiply* 456.37 by the specific gravity of the liquid, and the product will be the weight desired.

PRESCRIPTION-WRITING

The literal interpretation of the word *prescription* is *a written order for something*—from *præ*, for, and *scribo*, I write. The popular use of the term, however, relates to medicines, usually meaning a written order for medicines, although it is frequently employed to designate the remedy or mixture itself.

The art of prescription-writing is one that requires practice for its perfection, as well as a broad knowledge of drugs, their actions and their doses, and their indications for certain diseases. It is also essential to know the physical and chemic properties of drugs as related to the form of administration and possible combination with other substances. Through the development of the sciences of pathology and pharmacology we have learned that it is unnecessary to exhaust our materia medica in prescribing for any one disease, and with this more definite knowledge of the action and effects of drugs upon the diseased tissues, organs, and functions of the body, we find that only a few agents can be employed with actual benefit in our endeavor to assist Nature in her efforts to restore an abnormal to a normal condition. To-day simplicity in prescriptions is evidence of a broad knowledge of the conditions to be met by the application of drugs or remedies to the treatment of disease. In former days many drugs were combined in one prescription, and the remedy was given with the hope and expectancy that at least one ingredient might, perchance, hit the spot. To such formulas the term "shot-gun" prescriptions is now applied.

The most important considerations in *writing* prescriptions as well as in *reading* them are:

1. The language and abbreviations.
2. The signs and terms.

The *language* of prescription-writing is primarily Latin, because pharmacopeial titles are chiefly used in designating remedies. Medical Latin will be referred to later. *Abbreviations* in prescription-writing are perfectly proper, provided they are not carried so far as to cause confusion in compounding the prescription. The *signs* and *terms* used will be considered conjointly with the analysis of a prescription.

A prescription may be divided into five parts, as follows:

1. The superscription, or heading.
2. The inscription, or names and quantities of ingredients.
3. The subscription, or directions to the compounder.
4. The signa, or directions to the patient.
5. The name of the prescriber, his degree, and the date.

The *superscription*, or heading, consists of the abbreviation ℞ for the imperative of the verb recipio—*recipe*, with a terminal stroke on the R, forming the sign of Jupiter, ♃, which survives as a relic of ancient times when all medical formulæ were preceded by this sign as an invocation to Jupiter, the chief God. Literally translated "take thou" or "take," it tells the pharmacist to compound the ingredients which follow. The name of the patient is generally, though not necessarily, included in this part. A perfect prescription should always bear the name of the person for whom the medicine is intended, and if for a child it should be so designated.

The *inscription*, containing as it does the names and quantities of the ingredients, is the most important part of the prescription, and the ingredients are invariably written in Latin with the *genitive* ending, the quantities following on each line, indicated by the customary abbreviation. Thus: gr. for granum, plural grana—grain or grains; ʒ for dram (drachma); ℥ for ounce (unica); and O for pint (octarius). The abbreviations ℔. for pound (libra) and Cong. or C. for gallon (congius) are rarely employed. ♏ stands for minim (minimum); and the fluidrams and ounces are indicated by the prefex f, thus fʒj, f℥j. *Semissis*, abbreviated *ss*, is used to indicate a half. A prescription written with the troy system of weights always contains *Roman* numerals: gr. iv, gr. xx, etc.; when written with the metric weights and measures they are expressed in decimals in *Arabic* numerals, followed by Gm. or cc., signifying weight or measure: 5.65 Gm., 30.0 cc.

Signs for designating the measure or weight of the mixture are sometimes affixed to the last ingredient. The most commonly used are:

Ad, the preposition "to;" ad fʒiij = to (measure) three fluid-ounces. *Quantum sufficiat*, abbreviated q. s.—as much as is sufficient. Of these signs q. s. is preferable, since *ad* may be confused with the abbreviation of the verb *adde*, meaning to add. *Ana*, abbreviated *āā*, meaning "of each," is appended when the same quantities are required of two or more ingredients; it follows the last of these, just preceding the quantity.

While it is the rule that every word in the inscription must terminate in the genitive or accusative (the names of the ingredients in the genitive, the quantities in the accusative), they are rarely written out in full, but nearly always abbreviated. Where the first, or the first and second, syllables of words are the same, *e.g.*, hydrargyrum and hydrastis, the abbreviation must not be carried so far as to involve doubt as to which drug is really meant. To further illustrate, the drugs just mentioned are often abbreviated hydr., which may mean either of them, or when followed with chlor., would doubtless mean hydrated chloral, but might also be mistaken for hydrargyrum chloridum; both calomel and mercuric chlorid being sometimes erroneously, though not infrequently, so written. The author's experience behind the prescription-counter leads him to emphasize the importance of correctly writing the inscription.

The complete inscription is made up of the *basis*, or active constituent; the *adjuvant*, or aid to the basis; the *corrective*, or agent to counteract, modify, or correct some unpleasant property of the basis; and the *forming substance*. The forming substance is variously termed according to the form or consistence of the mixture. For liquids and ointments it is called *vehicle;* for powders, *diluent;* and when in a mass, as in pills or troches, *excipient*. This is according to the maxim of Asklepiades, which reads *curare* (basis), *cito* (adjuvant), *tuto* (corrective) *et jucunde* (vehicle, diluent, or excipient), to cure quickly, safely, and pleasantly. Most prescriptions do not contain all of these ingredients; many call for but one.

The *subscription* consists of certain signs and terms conveying directions as to the compounding and dispensing. Generally it is better to leave the detail of compounding to the pharmacist who is trained in the art of pharmacy; therefore, the abbreviation, M., which stands for the Latin imperative of the verb *misce*, meaning mix, is usually all that is necessary. This sign may follow a dash, thus —M., just to the right of the last ingredient in the inscription, or it may be placed to the left under the sign of the superscription. When special directions are necessary, as in directing the number of powder, capsules, or pills, into which the mixture is to be divided, they may be written in either Latin or English—the former is preferable, provided they are correctly written.

Special directions abbreviated are:

M. ft. pulv. chart. div. No.—, mix and make a powder, divide in papers No.—. M. ft. cap. No.—, mix and make capsules No.—. M. ft. mass. pil. div. No.—, mix and make a mass, divide in pills No. —.

The *Signa*, abbreviated Sig. or S., includes the directions to be written on the label and affixed to the package or container. These should be written in English in a plain, bold hand-writing. Sometimes it is better for the patient not to know what drug is taken; for this reason the inscription and subscription are written in Latin, but no secrecy is necessary here; in fact, to write the directions in plain English and to read them to the patient or attendant may serve as a check on any possible error in copying the directions on the label. The stereotyped expression, "Use as directed," should be avoided as far as possible, especially where the prescription is intended for internal administration. Many serious consequences might have been averted if specific directions had been given.

The *name* of the subscriber, his *degree*, and the *date* are added below the signa. Generally it is not in good taste to flourish the degree after one's signature every time it is written; but in the case of a prescription it is essential for authenticity. The pharmacist desires to know whether the prescriber has the right to prescribe, and this can only be known by the degree. When prescription blanks are used, having the prescriber's name, degree, and address printed above or below the space reserved for the prescription proper, all that is necessary is to write the initials and the date. The date is valuable for reference.

It may be questioned by some whether dentists have the right to prescribe internal remedies. A large part of the work of the dentist is to treat the diseases of the mouth and adjacent tissues, thus alleviating human suffering, and surely he has the right to use any drug which he knows from his experience will aid Nature in overcoming the pathologic condition. In this relation it should be mentioned that at present whisky and brandy cannot be prescribed by dentists owing to a ruling of the Federal Department having in charge the enforcement of the Volstead Act. The author entered upon the practice of dentistry through the gateway of pharmacy, and it has been his experience, both as a pharmacist and as a dentist, that the right to prescribe will never be questioned if intelligence is shown in the writing of the prescription.

The *order* usually adopted in prescription-writing is as follows: First, after the ℞, the names of the ingredients are written, in the order of their importance; then the number of doses is decided upon; the individual dose of each drug *multiplied* by the number of doses gives the quantities to be affixed to the names of the ingredients. In selecting the proper quantity for liquid mixtures, the regular sizes of vials alone are considered. These are 1, 2, and 4 dram, and 1, 2, 3,

4, 6, 8, and 16 ounce capacity, and it should be remembered that in all cases a bottle should be filled. A partially filled bottle immediately arouses suspicion on the part of the patient as to the possibility of mistake in compounding the prescription.

MEDICAL LATIN

The language used in prescription-writing is primarily Latin, because pharmacopeial titles are chiefly employed in designating remedies. It is never necessary to tell the patient what drug is being used, and frequently it is far better that they should not know, because of certain idiosyncrasies, prejudices, and other reasons. Therefore, it is wise always to write the inscription and sometimes the subscription of a prescription in Latin. The rule is to have the name of every ingredient end in the genitive and the quantities in the accusative. It is true that much ignorance of the Latin language can be covered up in prescription-writing by using abbreviations, and while it is also true that to abbreviate is perfectly proper, provided it is not carried so far as to involve doubt as to what drug is wanted, nevertheless, a working knowledge at least of this dead language will be of inestimable value. Therefore, a few rules of *Latin grammar* applicable to prescription-writing are here given: The quantities of the ingredients appear in the *accusative* case, governed by the imperative of the verb "Recipe;" the quantities, however, are seldom written out in full. The *names* of the ingredients appear in the *genitive* case, the construction reading "Recipe drachmam unam phenolis," take one dram of phenol, ℞ phenolis, ʒj. The directions to the pharmacist are very simple, unless special instructions are necessary: M. for "misce," is generally all that is required. The directions to the patient should always be written in English. All nouns ending in *a* in the nominative, end in *æ* in the genitive, and are of the first declension; the accusative ends in *am* and the nominative plural in *æ;* there are a few exceptions of Greek derivation, such as enema, gramma, theobroma—the genitive ending for these is *atis*. Nouns terminating in *us* in the nominative, end in *i* in the genitive, and are of the second declension, *um* for the accusative singular, and *i* for the nominative plural; there are a few exceptions to this rule with nouns of the fourth declension, as fructus and spiritus (these do not change in the genitive). The nouns ending in *um* in the nominative singular are neuter in gender and of the second declension; they change to *i* in the genitive, *um* in the accusative, and *a* in the nominative plural.

All other pharmacopeial nouns belong to the third declension and change variously in the different cases, and for the most part must be studied individually. For example: *as* becomes *atis; is* may remain *is* or change to *idis*, *itis*, or *eris* in the genitive; the accusative of *as* becomes *am*, the nominative plural *atea*. Some nouns do not change at all, *e.g.*, sassafras. Adjectives agree with their nouns in number, gender, and case; those ending in *us*, terminate with *a* for the feminine and *um* in the neuter gender, and are declined according to the first and second declensions. Adjectives ending in *is* and *ens* are declined according to the third declension; the first ends in *e* in the neuter gender. A few nouns of Greek origin end in *ë*, and form a genitive of *ës*, and an accusative of *ën;* aloe, aloës, is an example.

When special directions are necessary for the dispensing of *powders, capsules*, and *pills*, they may be given as follows: *Fiat pulvis et divide in chartulas No.* x.—make a powder and divide into 10 papers. *Dispensa in capsulis No. xij*—dispense in 12 capsules. *Fiant pilulæ No.* xx—make 20 pills.

An *official formula* may be specified in a prescription as follows: ℞ Pulveris opii et ipecacuanhæ, gr. xx. Fiat chartulas No. iv. Sig. —Take one or two powders on retiring and keep well covered. In this prescription the nominative pulv*is* changes to pulv*eris* in the genitive; opi*um* changes to op*ii;* and ipecacuanh*a* changes to ipecacuanh*æ*. Thus the value of the above rules of Latin grammar is seen. To abbreviate the names of the ingredients in the above, we could use pulv. for pulveris, ipecac. for ipecacuanhæ, but we could not intelligently abbreviate opii—it would be necessary to write it in full in the Latin nominative or the English (which is the same in this instance—opium). To write it in the Latin nominative in the inscription is wrong, and to write it in English with the other words abbreviated in Latin is also wrong. So, while much ignorance of the Latin language may be covered up by abbreviation in prescription-writing, occasionally this lack of knowledge will manifest itself; therefore, it is the wiser plan to become familar with these simple rules. As has been elsewhere stated, the art of prescription-writing is one that requires a great deal of practice for its perfection.

In conclusion the author desires to state that if any part of the inscription or subscription cannot be properly written in Latin, by all means write the entire prescription in English. This is by no means meant to discourage the use of Latin in prescription-writing.[1]

[1] Those desiring to study this subject further will find St. Clair's "Medical Latin" and Robinson's "Latin Grammar of Pharmacy and Medicine" excellent books for the purpose.

EXAMPLES OF PRACTICAL PRESCRIPTIONS

Powders.

For Mrs.————.

℞—Pulveris Acetanilidi Compositæ, gr. xv (1.0 Gm.)
Fiat chartulæ No. ij.
Sig.—Take one (1) powder at once and the other in two (2) hours, if not relieved.
(Date) ————, D. D. S.

For Baby ————.

℞—Hydrargyri chloridi mitis, gr. j (0.06 Gm.)
Sodii bicarbonatis, gr. xx (1.3 Gm.)—M.
Fiat chartulæ No. x.
Sig.—Take one (1) powder every hour until three (3) or four (4) are taken.
(Date) ————, D. D. S.

For Mr. ————.

℞—Acetphenetidini,
Salophen, āā gr. x (0.6 Gm.)
Codeinæ Sulphatis, gr. j (0.06 Gm.)—M.
Fiat chartulæ No. iv.
Sig.—Take one (1) powder every three (3) hours.
(Date) ————, D. D. S.

Tooth Powders.

No. 1.

For General Use.

℞—Calcii carbonatis ppt., ℥xiv (448.0 Gm.)
Saponis pulveris (U.S.P.)
Sucrosi pulveris, āā ℥ij (64.0 Gm.)
Sodii benzoatis, ℥ss (16.0 Gm.)
Eucalyptolis, ♏x (0.6 cc.)
Thymolis, gr. x (0.6 Gm.)
Cinnaldehydi, ♏xv (1.0 cc.)—M.
Fiat pulvis.
Sig.—Use as a general tooth powder.
(Date) ————, D. D. S.

No. 2.

For General Use.

℞—Calcii carbonatis ppt., ℥xx (640.0 Gm.)
Orris radices pulv., ℥iv (128.0 Gm.)
Saponis pulv. (U.S.P.), ℥ij (64.0 Gm.)
Sucrosi,
Sodii boratis, āā ℥j (32.0 Gm.)
Thymolis, gr. xv (1.0 Gm.)

Eucalyptolis, ♏x (0.6 cc.)
Olei gaultheriæ,
Olei menthæ piperitæ, āā ♏xx (1.3 cc.)—M.
Fiat Pulvis.
Sig.—Use as a general tooth powder.
(Date) ————, D. D. S.

Capsules.

For Mr. ————.

℞—Quininæ bisulphatis, gr. xxiv (1.5 Gm.)
Dispensa in capsulis No. viij.
Sig.—Take one (1) capsule before meals and on retiring.
(Date) ————, D. D. S.

Pills.

For Mrs. ————.

℞—Quininæ valerianatis, gr. xviij (1.2 Gm.)
Extracti hyoscyami, gr. iv (0.26 Gm.)
Extracti cinchonæ, gr. viij (0.5 Gm.)—M.
Fiat massa et divide in pilulæ No. xij.
Sig.—Take one (1) pill before meals and on retiring.
(Date) ————, D. D. S.
(*Cosmos.*)

Solutions (Dobell's Solution).

For Mr. ————.

℞—Sodii bicarbonatis,
Sodii boratis, āā ℥j (4.0 Gm.)
Phenolis (crys.), ℥ss (2.0 Gm.)
Glycerini, f℥j (30.0 cc.)
Aquæ, Oij (1.0 L.)—M.
Sig.—Use as a spray, mouth-wash, or gargle.
(Date) ————, D. D. S.

(Antiseptic Solution, N.F.)

For Mrs. ————.

℞—Liquoris Antiseptici, f℥viij (240.0 cc.)
Sig.—Dilute with one-half warm water and use as a mouth-wash.
(Date) ————, D. D. S.

For Miss ————.

℞—Antipyrini, ℥ss (2.0 Gm.)
Sodii bromidi, ℥j (4.0 Gm.)
Glycerini, f℥ij (8.0 cc.)
Aquæ cinnamomi, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Take a teaspoonful three times a day, after meals.
(Date) ————, D. D. S.

For Mrs. ————.

℞—Potassii iodidi, ℥jss (6.0 Gm.).
Syrupi sarsaparillæ comp., f℥iij (90.0 cc.)—M.
Sig.—Take a teaspoonful in water three times a day, after meals.
(Date) ————, D. D. S.

For Mr. ————.

℞—Acetailnidi, gr. viij (0.5 Gm.)
Syrupi, f℥ss (15.0 cc.)
Spiritus frumenti, q. s. ad. f℥iij (90.0 cc.)—M.
Sig.—Take one-half at once and the remainder in two (2) hours, if not relieved.
(Date) ————, D. D. S.

Collyrim (Eye-water).

For Mr. ————.

℞—Sodii boratis, gr. x (0.6 Gm.)
Acidi borici, sat. sol., f℥j (30.0 cc.)—M.
Sig.—Warm to body temperature and drop into the eye with a drop applicator.
(Date) ————, D. D. S.

Gargle (Mercurial Stomatitis or Sore Throat).

For Miss ————.

℞—Potassii chloratis, ℥jss (6.0 Gm.)
Tincturæ myrrhæ, f℥ij (8.0 cc.)
Alcoholis, f℥ss (15.0 cc.)
Aquæ cinnamomi, f℥vi (180.0 cc.)—M.
Sig.—Thoroughly gargle the throat three times daily. If too strong, dilute with warm water.
(Date) ————, D. D. S.

Liniments.

For Dentists' Use.

℞—Mentholis,
Iodi (crys.) āā gr. x (0.6 Gm.)
Chloroformi, f℥jss (6.0 cc.)
Tincturæ Aconiti, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Use as a refrigerant counterirritant.
(Date) ————, D. D. S.

For Dentists' Use.

℞—Mentholis, gr. xx (1.3 Gm.)
Chloroformi, f℥jss (6.0 cc.)
Tincturæ aconiti, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Apply freely to gums in cases of nonseptic pericementitis.
(Date) ————, D. D. S.

For Mr. ————.

℞—Camphoræ (gum), ℥ij (8.0 Gm.)
Tincturæ aconiti, f℥j (30.0 cc.)
Linimenti saponis, q. s. ad. f℥iij (90.0 cc.)—**M.**
Sig.—Apply locally with massage in case of neuralgia.
(Date) ————, D. D. S.

INCOMPATIBILITY IN PRESCRIPTIONS

When two or more different substances are brought together in a mixture, be it liquid or solid, with the result of undergoing a more or less complete change, not intended, they are said to be *incompatible.*

Incompatibility, so far as it applies to the combination (not the action) of drugs, may be of two kinds—*physical* and *chemic.* The only truly scientific method of determining the incompatibility, or the contrary, of the ingredients of a mixture is a correct knowledge of physical and chemic laws and their practical application in pharmacy and therapeutics.

Physical incompatibility is largely a question of the solubility of drugs. It results when precipitates are formed without the precipitated substance losing its former identity; *i.e.*, without chemic change. It also occurs when an effort is made to mix nonmiscible substances, as oil and water.

Gums and other mucilaginous substances are soluble in water, but insoluble in alcohol. Therefore, the addition of alcohol to an aqueous solution of a gum results in the precipitation of the gum without chemic change.

Example: Mucilage of tragacanth with any alcoholic tincture (tincture of aconite) will precipitate the tragacanth.

Resinous substances are soluble in alcohol, but insoluble in water. The addition of water, therefore, to an alcoholic solution of a resin results in the physical precipitation of the resin.

Example: Water added to tincture of podophyllum will precipitate the resinous active constituent, *podophyllin.*

Any mouth-wash or solution containing a considerable amount of the essential oils, held in solution by alcohol, will become turbid upon the addition of water, owing to the physical incompatibility of the oil and water.

Chemic incompatibility involves a chemic change when substances are mixed, whereby their former identity is lost. To be able to predict chemic incompatibility requires a knowledge of chemic laws and their practical application. It is well to remember a few of the more common of these laws. For example:

1. It is a principle in chemistry that when solutions of soluble salts are brought together there is generally an exchange of radicals

(ions) with the formation of a precipitate, if either of the newly formed salts is insoluble. To illustrate: When solutions of silver nitrate and sodium chlorid are brought together a white precipitate of silver chlorid is formed. Here there is an exchange of radicals, and the silver chlorid, being insoluble in the water, is precipitated, while the sodium nitrate, being soluble, dissolves as soon as it is formed. Advantage is taken of chemic incompatibility when silver nitrate is used about the mouth; any excess can be neutralized at once by having the patient rinse the mouth with a solution of common salt.

2. Strong mineral acids decompose salts of the weaker mineral or vegetable acids, and also form ethers with alcoholic preparations. To illustrate: Sodium bicarbonate is chemically incompatible with hydrochloric acid. Here the chlorin of the hydrochloric acid has a greater affinity for sodium than has the weaker carbonic radical, hence it displaces the latter, forming sodium chlorid and liberating carbonic acid, which immediately breaks up into water and carbon dioxid. The carbon dioxid, being a gas, causes the effervescence. An illustration of the formation of ethers by adding a strong mineral acid to alcoholic solutions is found in making ether, where sulphuric acid is added to alcohol. In this case, of course, sulphuric acid and alcohol are not considered incompatible because ether is the product desired; but if it were not, then they would be chemically incompatible.

As a matter of fact, all *drugs* are incompatible with their *chemic tests* or *antidotes*, a knowledge of which means a knowledge of the science of chemistry, and to mention all would be inappropriate in a work of this kind. A few common examples are here given:

Alkalies and *alkaline carbonates* are incompatible with *acid solutions*, *acid salts*, and *alkaloidal salts*. *Arsenic trioxid* with *tannic acid* and *salts of iron*. *Alkaloids* and *alkaloidal salts* with *tannic acid*. *Phenol* with *collodion*. *Powerful oxidizing agents* with *easily oxidizable substances*, causing combustion, and even explosion. Oxidizing agents are: potassium chlorate, potassium permanganate, chromic, nitric, and nitrohydrochloric acids. Easily oxidizable agents are: sugar, glycerin, alcohol, fats, sulphur, carbon, and phosphorus.

The following drugs, so far as possible, had better be prescribed alone:

Strong mineral acids.	Potassium Chlorate.
Alkalies.	Potassium Permanganate.
Arsenic Trioxid.	Silver Nitrate.
Iron salts.	Tannic Acid.

Mercuric Chlorid (incompatible with almost everything).

ANTAGONISM OF DRUGS

As has been observed in the study of physiologic action, certain drugs produce opposite effects. This is known as *antagonism of drugs*, called also *physiologic* or *therapeutic incompatibility*. The antagonistic effects of drugs are recognized in therapeutics as a means of guarding against *drug poisoning* and as an aid in the *treatment of poisoning* when toxic symptoms are manifested. In this connection the term *physiologic antidote* is used.

The antagonistic action of drugs, however, is never as positive as is the case with chemic incompatibility, for there are few drugs, indeed, whose action is directly opposite, and whose effects will neutralize completely the effects of other drugs. The antagonism of drugs or physiologic antidotes is well illustrated in the *treatment of cocain poisoning* (see p. 148).

DENTAL STERILIZATION

GENERAL CONSIDERATIONS

Throughout Part II of this work on Practical Dental Therapeutics the author will endeavor to emphasize the importance of *dental sterilization*.

The term Sterilization as used in medical and dental practice, means a process by which the destruction or removal of all microscopic living organisms and their spores is accomplished. Some bacteria, under certain conditions, undergo a transformation into a resting stage when they are called spores. In the spore state they are able to resist influences which would kill the bacteria. Most disease-producing germs do not form spores and, therefore, are easily killed. The anthrax and tetanus bacilli are exceptions to this, as their spores are quite resistant. The ordinary methods of sterilization will not kill spores, and in order to accomplish this end a process known as "fractional sterilization" is employed. Here the object or substance is subjected to a temperature of 100°C. in a suitable sterilizer for the purpose, for 20–30 minutes on at least two and ordinarily three successive days. By heating to 100°C. the bacteria are killed, but not their spores. The latter germinate as the fluid cools and are killed during the second heating. A few spores, however, will escape destruction on the second heating and will be destroyed by the third heating. Another important factor here is that the virulence and resistance of any organisms which survive are much lowered by the repeating heating.

An object which is free from living microorganisms is spoken of as being "sterile," but it should be remembered that this condition can be maintained only so long as the necessary precautions are taken to prevent contact with the atmosphere or other media or instrument which may carry microorganisms.

The methods and means of sterilizing tooth-structure and the field of operation will be fully discussed in the description of the various operations which are performed in and about the mouth; and while the importance of having the instruments and material used, as well as the operator's hands, in a sterile condition will be repeatedly mentioned, in all operations which involve in any way the soft tissues of the mouth where an infection may follow, the means of

sterilizing the same should now be discussed. The importance of personal cleanliness on the part of the dentist and of his armamentarium is, of course, understood and need not be considered here.

A principle in modern surgery is to prevent the presence of germs. This means that the instruments and materials used must be sterile, as well as the field of operation and the operator's hands. The same principle holds true in dental as well as general surgery.

METHODS OF DENTAL STERILIZATION

Direct Flame.—In dental practice it is often possible to sterilize small objects by the direct application of heat from the flame of the Bunsen burner or lamp, provided the object will not be injured. Such instruments as burnishers, root-canal pluggers, platinum needles, the points of pliers used for handling sterilized cotton, gutta-percha points, etc., may be rapidly sterilized in this manner by holding them in the flame, or playing the latter over them a few times.

Moist Heat.—The use of live steam for sterilization, usually in a covered kettle or boiler, electrically or otherwise heated, is generally applicable for sterilizing dental instruments, such as broaches, burs, pyorrheal scalers, etc. There are many practical devices on the market for this purpose. By practical here we take into consideration the convenience and expense. Such an apparatus must be convenient to use, and no reasonable amount of expense should deter dentists from accomplishing this end. This form of heat is the most efficient because the protein of the bacteria is more easily coagulated in the presence of moisture; its comparatively low specific gravity gives it great penetrating power, and during condensation latent heat is liberated. A temperature of 100°C. (the boiling point of water) for from three to five minutes generally is sufficient for the sterilization of such dental instruments as may be thus sterilized, and which are used and so sterilized several times daily. The instruments should be brushed with a stiff brush to remove whatever débris may be present before they are placed in the sterilizer, and the latter should be rinsed and fresh water added every morning. In cases of questionable specific infection, the instruments should be boiled for at least fifteen minutes. Sodium carbonate or borax should be added to the water to prevent tarnishing and probable rusting of the instruments. When dealing with the spore-forming bacteria, the fractional method of sterilization should be employed.

Dry Heat.—This method requires the object to be heated in an oven or suitable apparatus at a temperature of from 160° to 170°C.,

continued for at least two hours. It has only been within recent years that suitable apparatus for the practical sterilization of the material used in dental surgery, such as cotton, gauze, etc. has been obtainable; and, therefore, dentists have relied largely upon obtaining this material in sterile condition from the manufacturers. Even if this be possible, which is open to question, the material, with the best of ordinary care, becomes contaminated in the office. It is important, therefore, that all such material as may be sterilized by dry heat should be so sterilized just previous to use; and the better way to be assured of sterilization is to prepare this material in advance and keep it in a dry heat sterilizer ready for use. Such sterilizers are now on the market, and improved ones are being constructed. They should be a part of the equipment of every practising dentist. Where the material is kept constantly ready for use in such sterilizers, a much lower heat than 160° to 170°C. is sufficient.

Chemic Agents.—For the purpose of assisting in sterilization or of protecting substances from subsequent contamination, chemic agents are frequently employed. It is to be regretted that many of our most potent disinfectants, such as formaldehyd, mercuric chlorid, etc., while excellent for the sterilization of the hands and the site of operation, cannot be used for the sterilization of metal instruments, on account of the agents acting deleteriously upon the metal. These agents, therefore, should be used only as adjuncts, and generally in quantities insufficient to insure sterility in themselves.

This method is used in dentistry for the following purposes:

1. For the disinfection of the hands and the site of operation.

2. For the disinfection of tooth-structure, such as carious dentin, gangrenous canals, etc. Here stronger solutions of the drug may be safely employed—thus approaching more nearly complete disinfection than should be expected from the general use of chemic agents for this purpose.

3. For the disinfection of glass containers, etc., alcohol being chiefly used for the purpose; but sterilization by heat is better.

4. To maintain in a sterile condition various remedies, such as local anesthetic solutions, antitoxins, serums, vaccines, etc.

If done with aseptic precautions, it is best for the dentist to prepare local anesthetic solutions at the time they are intended to be used. However, stock solutions may be safely employed and can be kept sterile indefinitely by the addition of 0.5 per cent. of phenol or 0.4 per cent. of cresol. The latter is from two and a half to three times as strong a disinfectant as phenol and scarcely more poisonous.

It is impossible to set definite limits which will fit all cases for the amounts of the chemicals which may be employed, because the composition of the substance and its degree of contamination are important factors in sterilization.

Gutta-percha points may be positively disinfected by immersion in a 10 per cent. solution of formaldehyd or in a 70 per cent. solution of alcohol, to which latter solution should be added one grain of thymol to the fluid ounce. This solution will be known throughout the text here as *modified alcohol*. It is an excellent solution for the chemic sterilization of the teeth included in the rubber dam, and for the immediate disinfection of carious dentin. It may not completely sterilize in the latter instance, but it aids greatly in establishing asepsis by limiting the number and reducing the bacterial colonies. Of the organic bodies, alcohol stands first in dental practice as a disinfectant. It is an efficient antiseptic when present by volume in from 20 to 40 per cent. Solutions containing from 40 to 70 per cent. are actively disinfectant, the latter strength being most effectual. Above 70 per cent. its efficiency tends to diminish.

Iodin is one of the most effective disinfectants, and preparations containing free iodin in material proportions become sterile of themselves. For this reason solutions of iodin are valuable and largely used for disinfecting the mucous membrane previous to making submucous injections of local anesthetics, and before operating upon the part.

It is of interest for the dentist to know how the efficiency of disinfectants are determined. The most precise method of standardization is that now used in the U. S. Public Health Service. It is a modification of a method primarily employed by Rideal and Walker. To obtain the coefficient, the weakest dilution of the unknown antiseptic which kills in 2½ minutes, is divided by the weakest dilution of phenol which kills in the same time. The same is repeated for the weakest strength that kills in 15 minutes, and an average is taken.

The actual processes by which chemic disinfectants cause the injury or destruction of bacteria are not fully and definitely known. With agents like potassium permanganate, hydrogen dioxid and chlorin-liberating solutions, the destruction is due to rapid oxidation; with others, such as mercury bichlorid and silver nitrate, to the coagulation of the bacterial protoplasm; phenol, cresol, formaldehyd and basic analine dyes, to diffusion through the cell membrane and chemic combination with the bacterial protoplasm; alcohol—the best dental chemic disinfectant, causes destruction by

dehydration which is due to a difference in tonicity between the cell protoplasm and the disinfecting solution.

The responsibility of having all instruments and material used in dental surgery sterile, *where it is possible to cause an infection through an open wound or otherwise*, is rightfully thrown upon the dentist; and in assuming this responsibility he should study carefully the various methods of sterilization, and exercise judgment in his application of the principles involved.

PART II

PRACTICAL DENTAL THERAPEUTICS

GENERAL CONSIDERATIONS

Therapeutics is the application of drugs or remedies to the treatment of disease. Dental therapeutics differs in no way from general therapeutics, except that it includes only the treatment of diseases of the mouth and adjacent structures or such general diseases as are manifested in the mouth. In the latter instance it is the duty of the dentist to collaborate with the family physician in the treatment of the case. In this day when so many systemic diseases are known to be directly traceable to foci of infection in the mouth, it is more essential than ever that the physician and dentist work together in harmony for the relief of suffering humanity; for systemic disease, in large measure, can be prevented by the control of dental disease.

In considering the practical therapeutics of the more common diseases which the dentist is called upon to treat, the author will draw largely upon his own experience gained from actual practice and from extensive reading of current dental and medical literature.

It should be understood at the outset that there are three essential factors upon which all successful therapeutics rests. *First*, to be able to recognize a pathologic condition and make a correct diagnosis. This means that the successful therapeutist must possess a broad knowledge of general pathology and a special knowledge of dental or oral pathology; *secondly*, to know what drug, or remedy, if properly applied or administered, will reach the recognized pathologic condition and act the most favorably. This means that successful therapy depends upon a broad knowledge of pharmacology —a science which treats of the action of drugs and remedies upon the tissues, organs, and functions of the body; and *thirdly*, to have at hand, in a convenient and practical form, that drug or remedy which experience has taught will assist Nature in her efforts to restore an abnormal to a normal condition.

The tendency in dental as well as in general therapeutics to-day is to place the treatment of disease upon a rational basis. The progressive dentist, therefore, is no longer satisfied to know that results may be obtained by the use of certain remedies in the treatment of

certain diseases, but he has a strong desire to know also *why* those results are brought about. In the following pages only such pathologic data will be given as are deemed essential to the therapeutics of the condition under consideration, but every effort will be made to tell, as far as is known, why the remedies suggested are indicated and what may be expected from their judicious employment. This means that it will be necessary to practically discard all obsolete or untried remedies. In other words, only such remedies will be considered in detail here as have been found to be of real practical value.

DISEASES OF THE HARD TISSUES OF THE MOUTH AND ASSOCIATED STRUCTURES

HYPERSENSITIVE DENTIN

GENERAL CONSIDERATIONS

In the early history of civilization, we find that the possession of the cardinal virtue of fortitude was considered a mark of courage, strength and character, because it enabled the individual to willingly undergo the necessary pain, peril or danger incident to life. But the discovery of anesthesia by humanity's greatest benefactor, Horace Wells, the dentist, together with the humanitarian tendencies of the years, have so changed human nature that we find few people to-day who possess in any marked degree the spirit of fortitude as manifested in ancient times. Among other things in life, this condition of affairs demands more painless methods of practising dentistry. The one dental operation which has caused more pain in the past than all others combined is that of the preparation of cavities in vital teeth.

Ever since the art of filling teeth was first begun both the dentist and patient have cherished the ardent hope that some day it would be possible to perform this operation without pain. Especially is this true in these modern times when, to carry out the basic principles of cavity preparation, as understood to-day, it is necessary that the cavity have a flat seat with practically parallel walls; that it should possess powers of resistance and retention, and be of convenient form, and that the outline be carried to areas of immunity—all of which requires drilling into sound and usually extremely sensitive dentin.

Authorities differ in regard to the sensitivity of dentin. According to Barrett, dentin in the normal condition should be without sensation; the source of sensitive dentin, or of impressionable pulps, lies in their continued subjection to irritation by which responsiveness is developed. Burchard-Inglis states that all vital dentin is sensitive; that the degree of sensitivity differs markedly in individuals; and it is only when hypersensitiveness is observed that the condition becomes pathologic. It might also be mentioned that the sensitivity differs in the same individual at different times. Black differentiates between hypersensitiveness and thermal sensitiveness of dentin, claiming that the sharp pain caused by sudden

changes of temperature is normal, though no other tissue or organ of the body shows a like resistance to thermal changes. Under certain conditions hypersensitiveness to thermal changes may develop, when the condition becomes pathologic. Thermal sensitiveness as well as hypersensitiveness of dentin is often developed during the progress of decay; therefore, in the preparation of cavities for fillings we find few teeth the dentin of which is without sensation. This fact is not surprising, nor can it be construed as being contrary to the statement that normal dentin is not sensitive when we remember that there are few teeth in the mouths of patients demanding the services of the dentist, the dentinal fibrillæ and pulps of which have not been subjected to continued irritation.

Previous Attempts at Controlling Pain.—For years men of all classes, from the conscientious practitioner to the charlatan and quack, have endeavored to invent means or discover remedies for the elimination of pain caused by operations upon vital teeth. In 1836 Dr. Spooner, of Montreal, thought he had made the discovery when he introduced arsenic trioxid as a remedy for desensitizing dentin. In more recent years cataphoresis, high pressure injection of cocain, interosseous and conduction anesthesia have had their advocates. All kinds of local remedies have been suggested. General analgesia by chloroform and nitrous oxid has long been used by a limited number. Later, analgesia by somnoform or nitrous oxid and oxygen has been revived. Many are using these various agents to-day with more or less success—not because they are in full sympathy with the methods or means, but because they seem to be forced to use something; and their patients are willing to submit to almost any process if pain can be avoided.

Any method or remedy for the elimination of pain in filling teeth, which necessitates placing the tooth or patient in such condition that the dentin can be painlessly drilled to any depth, is a dangerous one to place in the hands of the profession in general. Pain is Nature's indicator, and pain should be our guide. The author has been of the opinion for years that the ideal method of desensitizing dentin would be the application of a remedy within the cavity which would affect the dentin only to a given depth, and thereby not reach nor affect the pulp.

In the discussion of means and methods by which the sensitiveness of the dentin can be allayed, I shall not attempt to enter into the details of the many histologic and pathologic phenomena which are certain to arise in the consideration of the *therapeutics* of this subject, but shall confine myself largely to the drug aspect.

The sensitiveness of the dentin can be obtunded in no small degree by the use of various therapeutic agents; and I might state that there are few operations which we are called upon to perform wherein the patient will appreciate our efforts more than in this of applying drugs and remedies for the mitigation of pain. But in order to apply intelligently and successfully any remedy, whether it be a drug or an agent, to the dentin and thereby obtund the sensitivity of the dentinal fibrillæ without endangering the vitality of the pulp itself, we must be familiar with several factors or conditions, which I cannot with propriety here discuss, in detail at least. For instance, a thorough knowledge of the anatomic and histologic structure of the tooth is of the highest importance, as is also a knowledge of the pathology, not only of the fibrillæ, but of the pulp tissue as well—the changes which these structures are capable of undergoing if unduly irritated by the application of the remedy employed. Still another factor, of equal importance and one which more directly relates to the phase of the subject under consideration, is a knowledge of the pharmacologic action and the therapeutic application of the drugs and remedies used for this purpose. Before using a drug or an agent for allaying the sensitiveness of dentin, or for any other purpose, we should know what *action* to anticipate from its employment. This is not too much to expect from the trained dental practitioner of to-day.

THERAPEUTICS

The remedies suggested in the past for obtunding sensitive dentin have been many and varied. I shall discuss only those which, from clinical experience, have proved of sufficient value to merit consideration; and, for convenience of study, will divide them into four general classes.

I. PHYSICAL AGENTS

There are some physical agents by the proper use of which the sensitiveness of dentin can, in a measure, be obtunded. The most common are:

Heat.	Light.
Cold.	Electricity.

Heat.—The application of dry heat to a sensitive cavity, especially in conjunction with a dehydrating agent, such as absolute alcohol, is always an aid; and this is accomplished by means of heating dry air, and gently directing a current of air thus heated into the cavity which has been isolated by the rubber dam and mois-

tened with the dehydrating agent used. Care must be taken not to primarily cause pain, otherwise the object of using the agent would be defeated.

Several apparatuses have been devised for heating the air. Dr. Rudolph Beck perfected a convenient electrical device by means of which compressed air can be heated as it passes through. Other such devices are on the market. In the absence of these, however, the chip-blower can be employed, but with less satisfaction. Inasmuch as heat is used in conjunction with another and more important class of remedies, I shall refer to this agent later.

Cold.—This is another physical agent sometimes employed for the purpose of desensitizing the dentin. Heat may be abstracted from the tooth-structure by spraying the cavity with a highly volatile liquid, like ether, rhigolene, or ethyl chlorid. In the use of these agents, advantage is taken of the physical law that *a solid in changing its form to a liquid, or a liquid in changing its form to a vapor or gas, must abstract from the thing to which it is applied a certain amount of heat in order to effect the change.* Ether, or combinations containing ether, and ethyl chlorid, both used as sprays, have proved valuable in some instances, especially in shallow cavities near the gum the dentin of which is difficult to obtund by the usual methods employed heretofore, and to which reference will be made later.

A precaution to be taken to prevent primary pain in applying this remedy is to fill the cavity temporarily with stopping and direct the spray first on this and surrounding parts, after which the stopping can be removed and the spray directed into the cavity without any appreciable pain. The degree of refrigeration must not be carried to the point of having subsequently a possible deleterious effect upon the pulp or gum tissue.

A practical method of combining dryness and cold as a means of obtunding sensitive dentin has been suggested by Dr. W. T. Reeves. It consists in directing a small jet of compressed air directly into the cavity a few moments before operating, and keeping it up during the drilling process. To prevent primary pain, cotton saturated with an analgesic and antiseptic remedy may be placed in the cavity first. The air serves a threefold purpose; it keeps the cavity dry; clears the field from chips; and, what is important here, it lessens the heat of drilling which is responsible for most of the pain in cavity preparation. Those inexperienced with the method must be careful at first, as the absence of pain and the clear field may lead one to think that the bur is not cutting; as a result one is liable to drill deeper than is absolutely necessary.

Whenever stones are used on vital teeth for any purpose, heat from the grinding may be reduced and pain prevented by keeping a gentle stream of tepid water flowing over the stone and tooth thus ground.

Light.—This agent has been brought forth at different times as having a peculiarly favorable effect upon hypersensitive patients. In one method the rays of light are colored by passing through a blue glass. This is accomplished by darkening the room and employing a blue bulb (16 or 32 c. p.) on an ordinary electric socket. Whether the light acts locally or affects the vision and thus the general nervous system has yet to be demonstrated. In the author's experience with this agent the result thus far has not been encouraging.

Electricity.—The electric current has been employed as a means of carrying certain drugs into the dentin and pulp tissue for obtundent purposes. The method is called *cataphoresis;* but because of the expensive and complicated apparatus, the length of time required to obtund, as well as the often unsatisfactory, and, in not a few instances, disastrous results, the method has generally been discarded.

II. ESCHAROTICS OR CAUSTICS

Any drug or agent which will cauterize the dentinal fibrillæ, will obtund sensitive dentin. There are many drugs, however, belonging to this class that cannot be used for this purpose because of their deleterious effect upon both the tooth structure and the pulp tissue. For instance, the strong mineral acids will disorganize the protoplasmic dentinal fibrillæ; but they will also disintegrate the inorganic structure of the tooth. Arsenic trioxid has a specific poisonous action upon the fibrillæ, but there is no known means of preventing the same deleterious effect upon the cells of the pulp tissue.

The most valuable escharotics for desensitizing the dentin are:

Phenol. Trichloracetic Acid.
Zinc Chlorid. Silver Nitrate.
Trioxymethylen.

It must be noted that, while these agents will obtund, the ultimate result is too often produced, with the possible exception of phenol, at the expense of quite as much suffering as they save.

Phenol.—This drug has local analgesic properties besides those of a cauterant, and will, therefore, be discussed under another and more important class of agents.

Zinc Chlorid.—Solutions of this drug of various strengths can be used to advantage in a class of cavities where the decay or softened

dentin does not extend too close to the pulp. Zinc chlorid coagulates albumin, and in the process hydrochloric acid is liberated. For this reason the application of strong solutions is painful and should not be resorted to in deep cavities unless the irritating action of the agent is modified. This can be done to a marked degree by selecting alcohol and chloroform as the vehicle in which to make the solution.

A useful formula is here given:

℞—Zinci Chloridi, gr. xx (1.3 Gm.)
Alcoholis, f℥iv (15.0 cc.)
Chloroformi, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Apply to the cavity on a small pledget of cotton and gently evaporate to dryness.
Note.—If the zinc salt in alcohol does not make a clear solution, it indicates that some of the salt has been oxidized; the solution can be cleared by adding one drop of dilute hydrochloric acid.

This is an excellent remedy to apply to the cavity immediately before using compressed air.

Trichloracetic Acid.—In concentrated solution trichloracetic acid causes considerable pain when first applied to a sensitive cavity, therefore defeating the object of its use; but in a 10 or 15 per cent. solution it produces but little pain or inflammatory reaction. In this strength it may be employed, but not always with satisfactory results.

Silver Nitrate.—This agent is perhaps the only known prophylactic drug for decay of tooth-structure. In the posterior part of the mouth where the cementum is exposed to external influences and thus is sensitive, or in shallow cavities, especially in children's teeth, the use of this drug, in the solid pencil form or in solutions of varying strength, will be found valuable, both as a means of reducing the sensitiveness and preventing further ingress of caries. As an agent for obtunding the sensitivity of the dentin in an ordinary cavity it should not be considered, for various reasons. When the agent is employed for the purposes above mentioned, the cavity, after the application, should be kept free from saliva for a few minutes, and, if possible, exposed to sunlight, thus decomposing the silver salt as referred to under the subject of *Light* (see p. 296). A solution of sodium chlorid should always be at hand when using silver nitrate, and in case any of the latter agent should accidentally get on the mucous membrane of the patient's mouth its action can be checked at once by rinsing the mouth with this antidotal soution.

Trioxymethylen.—The use of this drug for desensitizing purposes will be mentioned later under **Desensitizing Paste.**

III. LOCAL ANODYNES OR LOCAL ANESTHETICS

In the judicious use of agents belonging to this class the author firmly believes will ultimately be found the surest and safest road to success. This statement stands as it first appeared in this book (1909). Subsequent investigation by the author, which will be referred to later under *Desensitizing Paste*, has proven the correctness of the statement. The following agents, or a combination of two or more, will be found to be of the utmost value:

Cocain.	Eugenol.
Procain.	Phenol.
Neothesin.	Ethyl Chlorid.
Menthol.	Ether.
Oil of Cloves.	Chloroform.

Cocain.—Both the alkaloid, cocain, and the alkaloidal salt, cocain hydrochlorid, are used in various ways for obtunding sensitive dentin. An important physiologic property of cocain to be remembered here is its power, when applied directly to the mucous membrane or when injected or forced into the pulp tissue, of inducing a condition of analgesia in the part by paralyzing the sensory nerve filaments. In addition to this, it causes a blanching of the part which is subsequently followed by congestion. It should also be remembered that pharmacologists have proved beyond a doubt that cocain is a *general protoplasmic poison;* that muscles as well as nerves and nerve-ends cease to contract or to conduct stimuli when they are exposed to even dilute solutions of the drug. The only reason why the deleterious effect is more noticeable upon nerve than upon other kinds of tissue is that here we are dealing with the medium of sensation and expression.

The author deems it wise to call attention to these well-established physiologic, pharmacologic and pathologic facts, for many instruments have been devised for forcing solutions of cocain hydrochlorid of various strengths, not only into the dentinal tubuli, thereby paralyzing the fibrillæ, but into the pulp proper, anesthetizing this organ as well. In view of these facts, it would appear that we are *seldom justified in completely anesthetizing the pulp of a tooth for the purpose of painlessly preparing a cavity therein.* Therefore, under the subject of *Cataphoresis* previously referred to, little was written; and, for the same reasons, the method of anesthetizing the pulp by *high-pressure, interosseous*, or *conduction anesthesia* for obtundent purposes only will not be considered. These methods will be discussed subsequently under Pulp Removal.

Cocain and the alkaloidal salt, cocain hydrochlorid, are safe and reliable agents for obtunding sensitive dentin, if confined to the dentinal structure of the tooth. Frequently, in deep-seated cavities, especially in children's teeth, the sensitiveness can be completely overcome by sealing in the cavity for a day or two a creamy paste made by mixing the alkaloid with liquid petroleum. The *oleate of cocain* (N.F.) can also be used for this purpose. The paste or oleate should cover the entire surface of dentin which we subsequently expect to excavate. Good results can also be immediately obtained by the use of the following remedy:

℞—Cocainæ,		gr. xx (1.3 Gm.)
Chloroformi,		f℥ij (8.0 cc.)
Etheris,	q. s. ad.	f℥j (30.0 cc.).—M.

Sig.—After the rubber dam has been adjusted, apply to the cavity on a small pledget of cotton and evaporate to dryness.

In the use of this remedy, advantage is taken of the physical law previously referred to in connection with *Cold*. As the volatile liquids, ether and chloroform, evaporate, a certain amount of heat is abstracted from the tooth-structure, and a coating of the alkaloid, driven to an extent into the dentin, is left in the cavity. This remedy will not completely obtund all sensitive dentin, but its use will be a material aid.

There can be no objection in favorable cases, provided the dentin has been previously sterilized, to using aqueous solutions of cocain hydrochlorid with uniform pressure over the entire area of the cavity, thus forcing the anesthetizing solution an equal distance into the dentin. This is an extremely difficult thing to do without forcing the solution at some more favorable point in the cavity through the tubuli and into the pulp. However, there are cavities where good results can be accomplished by the careful use of this method. In some cases of gingival cavities good results can be obtained by hypodermically injecting a 1 to 1.5 per cent. solution of cocain hydrochlorid into the pericemental membrane somewhere near the apex of the root. This practice should not be generally recommended.

Procain.—This drug may be substituted for cocain and used as above described. Its action is much slower; and, for the purposes mentioned, it possesses no advantages. Sterile, isotonic solutions are recommended to be used hypodermically for *hypersensitive dentin*. The drug is injected by the infiltration, interosseous, and conduction anesthesia methods (see pp. 146 and 154, and works on Local Anesthesia.)

Neothesin.—The use of this agent in combination with other drugs for desensitizing dentin will be considered later.

Menthol.—This drug can be substituted for the cocain in the above prescription with ether and chloroform, and used in exactly the same manner. An oily liquid (mentho-chloral) can be formed by heating together over a water-bath, or rubbing in a mortar, an equal amount of menthol and chloral. This remedy will be found efficacious by sealing in the cavity for a few days.

Oil of Cloves.—A profound analgesic effect can be produced upon sensitive dentin, especially in deep-seated cavities, by using oil of cloves and heat in the following manner, as suggested by Dr. C. N. Johnson: After carefully desiccating the dentin by means of warm alcohol and gentle heat, a pledget of cotton saturated with oil of cloves should be placed in the cavity and a current of heated dry air directed thereon until the cotton is nearly dry. This should be repeated as often as the case demands.

Eugenol.—Eugenol is the chief constituent of oil of cloves and can be used in the same manner as the latter drug, as above described.

Phenol.—This drug can be substituted, with equally good results, for the oil of cloves or eugenol, as described in the foregoing method. Care should be taken here, however, in directing the heated air, that the fumes of phenol do not escape in the patient's face. Oil of cloves, eugenol, and phenol are three true *local anodynes*, any one of which, if hermetically sealed in a cavity for a few weeks, will check the continued irritation of the fibrillæ and pulp, and thus aid Nature to restore these structures to their normal condition when they should not be responsive. The author's phenol compound (see p. 357) is an excellent remedy for this latter purpose. By this means, then, the sensitiveness of the dentin can also be allayed.

Ethyl Chlorid, Ether, and Chloroform.—These agents, by their extreme volatility, produce a condition of analgesia, thereby obtunding sensitive dentin, as previously explained under *Cold*.

IV. GENERAL ANODYNES OR ANALGESICS

Before the introduction of Desensitizing Paste and the modern and improved methods of using local anesthetics, it was sometimes necessary in order to do permanent work for certain highly nervous patients to resort to the administration of this class of drugs. The agents largely used for this purpose are:

Opium. Amytal.
The bromids. Nitrous oxid.
Chloroform.

Opium.—This drug is a most powerful analgesic, and while there are some dental conditions where it or its chief alkaloid, morphin, is truly indicated, the drug ought not, in the author's judgment, to be given for the treatment of sensitive dentin.

The Bromids.—The bromids of potassium, sodium, and ammonium are valuable drugs in certain cases. Perhaps there is no drug which will quiet a nervous patient more readily, when the nervousness comes purely from fear or dread, than potassium bromid, which is the representative of this class. In such cases, where it is deemed necessary, the following prescription will prove helpful:

℞—Potassii bromidi, ℥jss (6.0 Gm.)
Syrupi sarsaparillæ comp., f℥iij (90.0 cc.)—M.
Sig.—Take a tablespoonful in water after meals the day before coming to the office.

Amytal.—This is a new drug and will be found efficacious in the preparation of cavities in teeth with hypersensitive dentin, especially with that class of patients who come to the dentist with fear and dread. Amytal is given orally in tablet form either with water or warm milk. For our purpose here as a sedative one tablet (1½ gr.—0.095 Gm.) taken an hour before operating should be sufficient. One great advantage in administering amytal for any purpose where a sedative on hypnotic effect is desired is the complete absence of any after effects of the drug.

Nitrous Oxid.—There are varying apparatus on the market by which nitrous oxid gas can be administered through the nose. It is possible with such an apparatus to carry the patient just to the analgesic stage, and hold him under its influence until a sensitive cavity has been painlessly prepared. Oxygen, in proper proportions, is generally mixed with the anesthetic agent for this purpose, as it overcomes the cyanosis which frequently follows the prolonged use of nitrous oxid alone. In cases where the operator feels that it is necessary to resort to this method, good results can be accomplished.

Chloroform.—With the patient in the upright position, chloroform can be carried to the analgesic stage and sensitive cavities prepared. Most authorities agree, however, that chloroform should not be administered unless the patient is in the recumbent position, and that the analgesic stage is the most dangerous. Death has been known to occur suddenly after a few inhalations in cases of marked idiosyncrasy against the drug.

Hewitt, De Ford, and others report excellent results from the use of chloroform in the manner described above. In selected cases the

author has used the method with uniformly good results; but the general use of the drug in this manner is not advised.

DESENSITIZING PASTE

Desensitizing Paste is a preparation introduced by the author to the profession as an absolute *specific* for *hypersensitive dentin*. The formula contains neothesin, thymol and trioxymethylen, in the proportion of 11, 12 and 77 parts, respectively; all combined with a petroleum base, and incorporated in a fibrous vehicle and colored with an insoluble pigment. One grain of the preparation is sufficient for about fifteen applications. On this basis the amount necessary for one application contains neothesin $\frac{1}{300}$ gr., thymol $\frac{1}{270}$ gr., and trioxymethylen $\frac{1}{43}$ gr. The use of the remedy in the hands of careful operators is safe and absolutely reliable. In the hands of careless operators no effective remedy or method of desensitizing dentin is safe. The dental pulp is a delicate and highly susceptible organ, and it must, therefore, be handled with intelligence and care. Most patients who repose *confidence* in the operator are sensible, and are willing to endure some pain in the preparation of cavities in their teeth. With confidence, a true running engine, a sharp bur, a dry cavity, a steady hand, and a knowledge of what ought to be done in a given case, it is not necessary to use Desensitizing Paste or any other absolute and positive means of desensitizing the dentin in every case which presents. Yet, it must not be forgotten that the preparation of cavities in vital teeth without some means of obtunding the dentin more positively than has been done in the past, is generally a painful operation which is dreaded by most patients.

In his work on "Operative Dentistry," published in 1908, on page 149, Dr. G. V. Black says: "The treatment of sensitive dentin for the purpose of relieving or limiting the pain in the excavation of cavities has been prominently before the dental profession since the first discovery of anesthesia, and, perhaps, for many years before that time. Personally, I have watched the progress of this effort through many years of what has been fairly close, careful observation in clinical practice, and always with an earnest desire to relieve patients of suffering in the necessary cutting in the preparation of cavities. In all of this time, and up to the present, the results have been so poor, or so uncertain, that, as compared with skillful use of well-selected cutting instruments, well-tempered and always sharp, they have not been a success." The author concludes by saying: "But

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the relief of suffering is an ever-present duty, and the search for this very desirable thing should continue."

Physiologic Action.—It is highly essential that we understand how desensitization is brought about when Desensitizing Paste is applied to the dentin. The neothesin applied directly to the exposed sensitive dentinal fibrillæ acts quickly thereon and temporarily paralyzes the ends thus exposed. The thymol volatilizes and permeates the softened dentin. The heat of the body gradually liberates formaldehyd from the trioxymethylen, which gas diffuses through the decayed dentin, combining chemically with the amine group of the protein constituent of the dentinal fibrillæ. The formaldehyd also acts upon certain intermediate and end-products that may be present in the carious tooth-structure as a result of albuminous decomposition, and this agent, together with the thymol, brings about *complete sterilization*. Thus the dentin affected by the remedy is not only *desensitized*, but *sterilized* as well, which is an all-important factor. The vitality of the fibrillæ is destroyed in the area affected, but the remedy will not affect sound dentin to any dangerous depth. In the preparation of the cavity, in the average case, the dentin affected by the remedy is practically all removed. If it is not, I know from my experience with the preparation that the vitality of the fibers is subsequently restored, for after a few weeks sensation returns. While this regeneration is being brought about, the tooth may develop slight *thermal sensitiveness* which lasts for about a week. This occurs only in a small percentage of cases. It is mentioned here simply that the operator may know the cause, and that should such sensitiveness develop, it will be of short duration.

Indications.—Desensitizing Paste may be used with perfect safety in all cases of hypersensitive dentin where the pulp of the tooth is not diseased to the extent of necessitating the removal of the organ because of its pathology. As has previously been mentioned, it is not necessary to employ the remedy in every case of cavity preparation. Where the pain is not great, and where the patient is willing to endure the small amount, no therapeutic remedy is needed; but every dentist has cases in which it is impossible to do satisfactory work because of the hypersensitiveness of the dentin. In all such cases the use of Desensitizing Paste will prove a blessing to humanity and a godsend to those earnest practitioners who have grown gray and nervous standing at their chairs trying to properly prepare cavities in the teeth of hypersensitive patients.

Making the Application.—In employing Desensitizing Paste, it is not necessary to remove any of the carious dentin that is at all sensitive. To attempt this often causes pain, and the remedy, if used at all, is intended to, and will, *absolutely eliminate all pain in cavity preparation*. The cavity and immediate tooth-surface should be dried with alcohol and a small amount of the paste sealed therein with a good cement. Better results will be obtained if the remedy is spread over the cavity surface. This can be accomplished with a ball of cotton held in the pliers. In gingival cavities, such as is illustrated in Fig. 13, it is often necessary to flow the cement over the enamel surface, depending entirely on its adhesiveness to hold the paste on the softened tooth-structure.

Twenty-four to forty-eight hours is sufficiently long to bring about complete desensitization, and this is the proper length of

FIG. 13.—Prepared cavity.

time to leave the remedy sealed in a tooth. However, no harm will follow if the paste should remain in the tooth for a longer period. The small amount employed will soon exert its full influence, after which no further action follows. An effort should be made to hermetically seal all the margins of the cavity—thus confining the action of the remedy to the dentin. This is sometimes difficult to do with gingival cavities. If it is not accomplished, a certain amount of the formaldehyd gas may escape as it is liberated, in which case the dentin would not be profoundly affected.

When it becomes necessary to prepare a cavity in practically sound dentin, as is frequently the case for bridgework and in superficial cavities, it may be necessary to make a second application of the paste in order to prevent any pain. In all cases where there is considerable decay, one application will be sufficient to desensitize the entire cavity. The depth to which the dentin is affected by the remedy will depend upon the condition of the dentin. In using Desensitizing Paste it will be found that in about 5 to 10 per cent. of all cases the teeth to which it has been applied with grumble or

have a tendency to ache. If the remedy has been used where indicated, no alarm need be felt because of this, for it will subside in a few hours.

Precautions.—There are no special precautions to be observed in using Desensitizing Paste, so far as the remedy itself is concerned. It will not even destroy normal gum tissue to any appreciable extent, at least, if sealed in contact with it. It will be necessary, however, for the dentist who desires to use this remedy intelligently to so school himself in pulp pathology that the remedy may not be used in those cases where the reading of the clinical symptoms would clearly indicate the removal of the pulp.

In deep-seated cavities which approximate the pulp, yet where the organ is not diseased to the extent of necessitating its removal, the paste need not be applied to the entire cavity. In these cases very small doses may be placed over such areas only as will need to be drilled subsequently in the cavity preparation, and some anodyne remedy like phenol compound placed immediately over the pulp. The danger in using this preparation does not lie in the possibility of affecting deleteriously a healthy pulp, provided there is sound dentin between the bottom of the cavity and the pulp proper, but rather in the probability of diseased pulps being left in teeth to die and putrefy, because of the absence of sensation in the dentin after the remedy has been used. The decision, therefore, as to whether or not the pulp is diseased and removal necessary should be made before employing Desensitizing Paste.

In my clinical experiments I have, at times, purposely used the paste in cavities of extensive decay, where I suspected the pulp was affected. At the subsequent sitting I was able to painlessly remove all of the carious dentin which extended very nearly, and in some cases quite to the pulp. In cases where the pulp was exposed it was found to be sensitive and would bleed freely, indicating, to my mind, that it had not been affected by the remedy. However, it is our plain duty in such cases as these to remove the pulp, for I do not believe that decay can extend to or nearly to the pulpal organ without the latter being affected by the carious process, if not infected by the germs present in the cavity.

Caution in Relation to Diseased Pulps.—In detailing the use of this valuable remedy I wish specifically to call attention to the fact that every dentist has had cases in his practice where vital teeth have ached after permanent fillings have been inserted, and that pulps occasionally die following these operations. Unless the dentist is well posted on pulp pathology and is cautious in his diag-

nosis similar experiences will follow the use of Desensitizing Paste. If such should be the case, however, it will be through no fault of the remedy—it will be the fault of mistaken diagnosis. I can understand how much harm may follow the use of any remedy or method by which cavities can be painlessly prepared. In the hands of the careless operator pulps may be left in which should have been removed. In the hands of that great army of conscientious practitioners, who constitute the vast majority, Desensitizing Paste will lighten their burdens and prove its worth (Fig. 14).

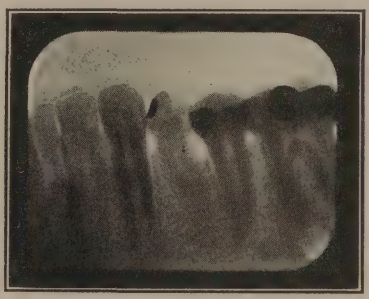

FIG. 14.

FIG. 14.—This radiogram was taken of one of the first cases in which the author used Desensitizing Paste in his practice. The patient was a girl about fourteen years of age whose teeth were extremely hypersensitive and decayed rapidly. On account of the nervousness of the little patient and the hypersensitiveness of the dentin, only temporary work could be done. This first lower bicuspid erupted when the child was seven years old, and began to decay at once. As will be noticed it is a malformed tooth. A small mesial cavity had been filled with amalgam. The larger distal cavity was filled several times with cement.

Desensitizing Paste was applied on April 3, 1914. The following day the cavity was prepared absolutely without pain in the presence of several dentists during the "Office Clinics" held in connection with the Fiftieth Anniversary of the Illinois State Dental Society.

The cavity was subsequently filled with porcelain. On account of lack of proper anchorage: (over one-half of crown was gone) this filling came out the following January. I decided to fill the cavity with synthetic porcelain. Upon drilling for anchorage, the dentin was as sensitive as though it had never been completely desensitized. The radiogram was taken April 3, 1916, two years after desensitization; and the tooth has been tested for vitality every few months with the electric current. The case is one of hundreds in the author's practice which prove that, properly used, Desensitizing Paste will not kill the dental pulp.

In closing, I want to say that the dread of the dental chair, the severe nervous strain upon dentists, the failure of operative procedures upon vital teeth and the ruthless destruction of the dental pulp, with its frequent evil sequelæ, have been more largely due to hypersensitive dentin than to all other causes combined. It is a great pleasure and satisfaction, therefore, for the author to here discuss the uses of Desensitizing Paste in connection with the therapeutics of this condition.

DIAGNOSIS AND TREATMENT OF DISEASES OF THE DENTAL PULP; INCLUDING THE DESTRUCTION AND REMOVAL OF THE ORGAN

GENERAL CONSIDERATIONS

In the treatment of the dental pulp, as in all other therapy, it is highly essential that we differentiate between the various kinds of diseases of this organ, and by means of reasoning, using common sense and judgment, and the process of exclusion, arrive at a correct diagnosis before applying our therapeutics. Any other method of procedure is little short of guesswork; and we must admit that there has been too much guessing at results, on the part of many, in the dental therapeutics of the past. In order to correct this evil we should delve more deeply into the science of pathology, and then, learning to properly interpret the clinical manifestations of these various diseases, we can select and apply our remedies along more rational lines.

The Normal Dental Pulp.—To know a tissue or organ in disease one must first know it in health. Therefore, let us briefly review the anatomy and physiology of the dental pulp (Fig. 15). Our histologists inform us that this organ is the remains of the original dental papilla, changed somewhat to meet its present environment, and is composed of soft embryonal connective tissue, with an outer layer of odontoblastic cells, the whole being well supplied with blood-vessel and nerves. The blood-vessels of the pulp are supposed to communicate with the general circulation through the apical foramen or foramina of the tooth. One or more small arterial trunks enter the pulp cavity at the apex, and, coursing occlusally through the center of the tissue, give off many branches. Near the occlusal end of the pulp they further divide into capillaries, and form a fine plexus around the peripheral portion of the pulp. The blood-vessels are generously distributed through the tissue. The veins form a similar plexus, and a central vein, analogous to the artery, receives the blood from these many venules and conducts it through the apical foramen. The nerves of the pulp are transmitted through the apical foramina together with the blood-vessels. Several bundles of medullated nerve fibers enter the foramen and break up into a plexus of nerves, which are widely distributed through the pulp tissue (Turner).

Character of Blood-vessels.—The walls of the pulpal blood-vessels are unusually thin. The arteries are found to be almost devoid of the external fibrous coat; and, according to Noyes, the muscular layer is represented by a single involuntary fiber, while the walls of the veins are formed by a single layer of endothelial cells. It had long been thought that the pulp tissue, like the brain, contained no lymphatics. This was considered of great pathologic significance in its relation to the thinness of the walls of the blood-vessels and the further facts that the organ is confined within a cavity having unyielding walls. Noyes, however, in his more recent investigations has demonstrated beyond a doubt the presence of lymphatics in the dental pulp. This may account in large measure for the known recuperative powers of the organ under certain conditions when properly treated and protected from external irritants.

Common Sources of Irritation.—Before taking up the pathology of the pulp, let us consider for a moment some of the more common sources of irritation of this organ and pericemental membrane, due to ignorance or carelessness, or both, on the part of dentists. So far as drugs are concerned, I am of the opinion that alcohol causes more irritation to these structures than any other one remedy. Ethyl alcohol, 95 per cent., is a most excellent agent, but a much abused one in dental practice. For removing the gelatinous coating and sterilizing the crowns of teeth included in the rubber dam, it is invaluable, but it is never necessary to use alcohol in this strength to desiccate or sterilize the dentin of a cavity in a vital tooth which we desire to fill, or for desiccating a canal previous to the insertion of a root-filling. That these results can be accomplished by using this agent, no one will deny; but, if we will only stop to consider, we must also know that the results are too frequently obtained at the expense of irritation of the pulp and tissue in the periapical region. I know that the use of 95 per cent. alcohol for such purposes has long been an established practice, and how startling and, to some perhaps, unfounded these statements may appear; but, nevertheless, I know too that these indictments against the indiscriminate use of alcohol in the treatment of teeth are justifiable, when we are considering the etiology of these diseases. What then shall we use as a substitute? My answer is to use either *alcohol modified*, which is 70 per cent. alcohol and 30 per cent. water, to which solution 1 gr. of thymol is added to each fluidounce; or a 10 per cent. alcoholic solution of phenol compound, or some other remedy having similar properties—those of desiccant, anodyne and disinfectant. The popular belief is that phenol is like an oil and that it is neces-

sary to follow its use in a cavity, for example, with ethyl alcohol in order to have the cement adhere. This is an erroneous idea. Phenol, though oleaginous in its physical appearance, is not an oil, any more than is sulphuric acid which is also oleaginous in character. Phenol is an alcohol and can be evaporated with warm air almost as readily as ethyl alcohol, and absolutely without irritation (pain) of the tissues involved.

Still another common and fruitful source of pulp irritation is the lack of protection to the organ in our extreme methods of cavity preparation in filling vital teeth, frequently resulting in the metallic inlay or filling being placed in too close proximity to the pulp. It is not my intention to decry the principles involved in Operative Dentistry; but my experience has taught me that in filling proximo-occlusial cavities in molar and bicuspid teeth, especially with inlays, with the opportunity afforded for occlusal anchorage, it is not necessary to approximate the pulp as closely as is advocated by some teachers on the ground of principle. This word "principle" is a broad term, and we should remember that there are principles involved in the treatment and protection of the dental pulp as well as in the retaining of a filling or inlay in the tooth. I have long since stopped trying to make myself and my patients believe that teeth, the pulps of which are thus continuously irritated by thermal changes, will soon be cared for by Nature, when no further trouble will be experienced. On the contrary, I know that while Nature is a kind mother, sometimes I think so kind that we are inclined to take undue advantage of her, yet in the majority of cases, both constructive and destructive diseases result which subsequently necessitate the removal of the pulp.

Many pulps have been irritated and frequently passive hyperemia or inflammation has been produced by the injudicious use of gutta-percha for sealing-in dressings or for separating purposes when proximal cavities existed. Unless due care is taken in the use of this material, even when the cavities are not deep and when no active hyperemia is present, infectious material or the medicine is liable to be forced through the dentin and into the pulp, causing the diseases above mentioned and jeopardizing the life of the organ. Cement had better be used for temporary sealing purposes, and before separating carious teeth with gutta-percha the cavities should be cleansed of débris, and the dentin sterilized. The cause of pulp trouble following the filling of a vital tooth can often be traced to the lack of sterilization of the dentin before the filling was inserted.

Let it be remembered that *preventive therapeutics* is the watch-word of the hour.

It should be understood, then, that the dental pulp is a delicate and susceptible organ, responding to the slightest irritation, it matters not whether the irritant be of a thermal, mechanical, chemical, or electrical nature. Inasmuch as any one of these various classes of irritants may cause hyperemia of the pulp, and this disease, if continuous and progressive, may result in more serious pathologic conditions, I will now direct your attention to the pathology of this organ, considering the etiology, diagnosis and treatment of (1) such Constructive and (2) Destructive Diseases as are commonly found in the general practice of dentistry.

CONSTRUCTIVE DISEASES

SECONDARY DENTIN

The deposition of what is known as *secondary dentin* frequently occurs in the pulp-chambers of teeth as the result of slight but continued irritation of the pulpal organ, after it has enjoyed a physiologic period of rest from dentin formation. This particular calcific deposit is always attached to the dentin, immediately under the site of irritation; and, if produced in a limited amount only, affords a natural protection to the pulp. The causes of secondary dentin are many and varied. The stimulus may result from such external irritation as follows:

1. *Exposed Cementum.*
2. *Abraded or Eroded Surfaces.*
3. *Cavities of Decay.*
4. *Metallic Fillings.*
5. *Gold or Porcelain Jacket Crowns upon ground-down vital teeth, etc.*

It is possible and oftentimes advantageous to so treat, stimulate and yet protect the pulp in cases of deep-seated cavities that a layer of secondary dentin will be deposited. I shall refer to this again in connection with the treatment of active hyperemia of the pulp.

In those cases where the stimulus continues over a period of years, we are quite likely to find the pulp-chamber and root-canals filled with secondary dentin. The diagnosis and treatment of this condition is unimportant unless untoward symptoms arise indicating an acute apical pericemental involvement or neuralgia, in which case the pulp should be removed. The radiogram here is an invaluable aid in arriving at a correct diagnosis. The removal of the pulp in these cases is often a difficult problem, for neither cocain hydrochlorid nor arsenic trioxid will affect pulps thus diseased in the usual way. It is frequently necessary to resort to conduction or interosseous anesthesia or to the administration of nitrous oxid and oxygen in order to remove these pulps without pain. Many an obscure case of neuralgia has this condition as its greatest etiological factor. This will be referred to again in detail under the

Diagnosis and Treatment of Neuralgia. The author has had many cases in his practice where the canals were nearly and in some instances completely obliterated without any untoward symptoms being manifested. Such a case is illustrated in Fig. 16. In this case I desired to insert a bridge. On opening into the third molar and second bicuspid, which teeth were to be used for the abutments, we were unable to find any canals in the bicuspid and only a small lingual canal in the molar. The radiogram confirmed

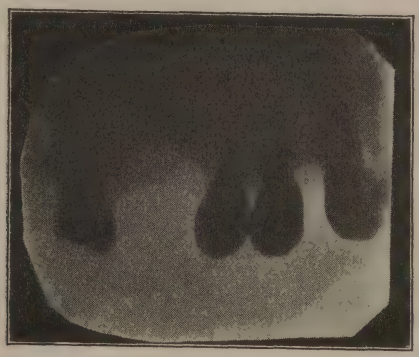

FIG. 16.

the clinical findings. The patient gave a history of having had an operation for abscess of the frontal sinus and both antrums about ten years previous. The bridge was inserted in January, 1909, and has given no trouble since.

PULP NODULES

Pulp nodules are calcific bodies of varying shapes and sizes, supposedly the result of secretion, and occurring within the pulp, rarely, if ever, being attached to the dentin. They are found more generally in middle-aged or elderly patients whose teeth have been subjected to that continued irritation the source of which was mentioned as an etiologic factor in the formation of secondary dentin. Black, however, observes that pulp nodules may, and frequently do, form in other teeth of the same denture which are not directly involved in the irritation; and that irritation of the pulp of one tooth very frequently causes a general hyperesthesia of the pulps of all the teeth in that mouth; especially is this true of that type of individual classed as neuralgic.

The diagnosis of pulp nodules is not always a simple matter. The symptoms are of the subjective variety, and the radiogram does not always confirm the suspicion. Moorehead, Raper, and others have reported cases where pulp nodules are distinctly shown

in the picture. The author has recently observed several such cases. On opening into the tooth the nodule was found to be present.

In Fig. 17 is shown the best specimen of a pulp nodule that I have ever seen. The tooth is a lower third molar and was extracted because it was causing more or less trouble. There is but slight mechanical abrasion and no other known cause for the pathologic

FIG. 17.

condition. Fig. 18 shows a pulp nodule nearly one-quarter of an inch long which fits the canal as perfectly as a pea fits the pod. The tooth for years had carried an ill-adjusted gold shell crown, which had been placed without devitalization and the proper trimming of the root. In the illustration also are shown several nodules of varying shapes and sizes, such as are commonly found in practice. The

FIG. 18.

following five illustrations are from Dr. Howard R. Raper, of Albuquerque, N. M., a dental radiographer, whose opinion I value highly. His description follows:

"Fig. 19. The upper arrow points to a pulp nodule in a lower first molar. The radiogram is by Pfahler, of Philadelphia, and I have no reliable history of the case. The radiogram would lead me to believe that the pulp-chamber has been opened up and much of the dentin cut away from about the nodule; hence the latter can

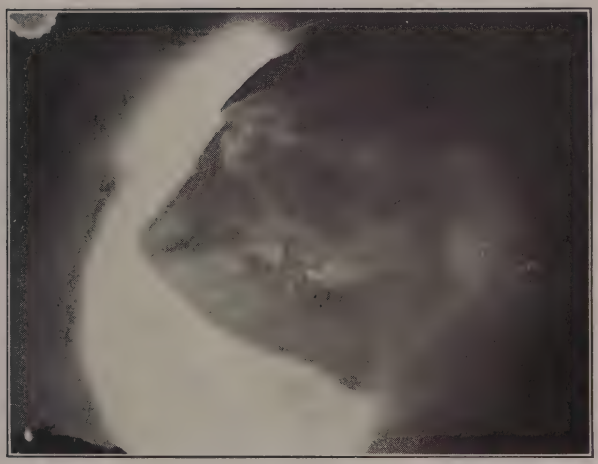

FIG. 19.

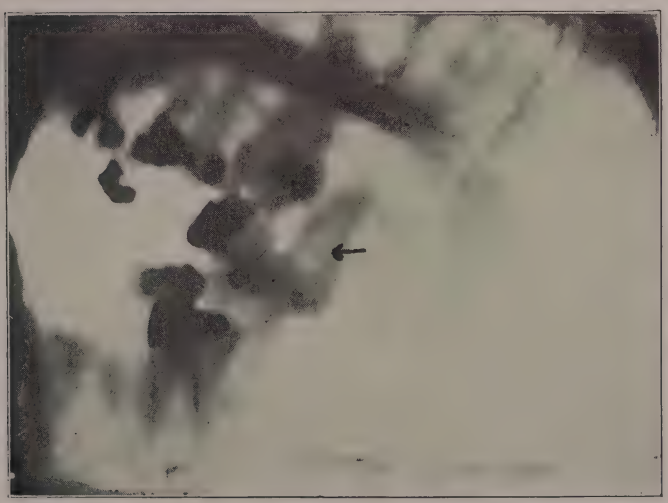

FIG 20.

FIG. 21.

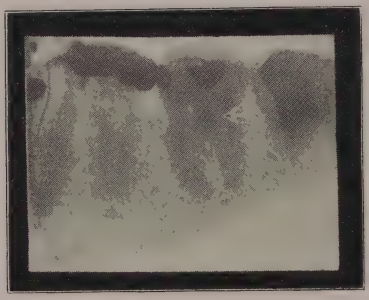

FIG. 22.

FIG. 23.

be seen much more clearly than any other I have ever seen in a radiogram.

"Fig. 20. In this case the upper third molar is missing. A pulp nodule is seen in the pulp-chamber of the upper second molar. This molar has not been opened as yet, nor will I advise the operator to open the tooth until I have made another radiogram to verify the findings in the first one. The case is one of neuralgia with an obscure etiology and a history of pulp nodules having been found in other teeth. I am, therefore, strongly of the opinion that the shadow seen in the radiogram is a pulp nodule. The radiogram shows also a faulty canal filling in the lower molar—a condition capable of causing pain. The treatment of the lower molar, however, has failed to give relief, which leads me to believe that the neuralgia is due to the pulp nodule.

"Fig. 21. This is a case from the practice of Dr. M. L. Rhein, of New York, and shows a pulp nodule in an upper lateral incisor with an abscess at the end of the incompletely formed root. The diagnosis was verified by removing the nodule.

"Fig. 22 shows a shadow in the lower first molar which might be mistaken for a pulp nodule. The shadow is a small amalgam filling on the buccal near the gingival line.

"Fig. 23. These negatives show nodules in all four lower incisors. The nodules in the central incisors extend practically from chamber to apex. The teeth have been extracted and dissected and the diagnosis verified. Though these nodules can be seen in the negatives it is improbable that lantern slide cuts made from the negatives would show them.

"There is no longer any doubt as to whether or not pulp nodules can be radiographed. With modern technic, we get results which are photographically good enough that we can be quite certain of the existence of a pulp stone from a single first class negative. Formerly it was thought necessary to have at least two negatives for diagnosis in these conditions." Dr. Raper is now also of the opinion that there are millions of pulp stones in teeth which cause no trouble whatever; and he advises the removal of a pulp stone only as a last resort, when positively nothing else can be found which might cause the trouble.

The treatment of teeth containing pulp nodules which are causing neuralgia or other disturbances is practically the same as that of secondary dentin, which involves the removal of the pulp, and will be considered later.

DESTRUCTIVE DISEASES

It is often a difficult problem for the conscientious operator to decide upon a method of procedure that will best conserve the interest of the patient. Especially is this true when we are trying to determine whether a diseased pulp should be saved or whether it would be best for all concerned to destroy and remove it. It is so easy in most cases to anesthetize or devitalize the pulp that many dentists resort to this method of treatment in nearly all diseases of the organ. When we consider the fine and tortuous canals which we so frequently encounter and the difficulty, both of removing the dead tissue from such canals and of thoroughly filling them subsequently, and the infection which so frequently follows if this is not accomplished, it is a question whether or not the best interest of the patient is conserved by adopting this method as the general practice.

While it is true, generally speaking, that pulps which are diseased beyond the condition of active hyperemia should be removed, it is also true that this organ has been destroyed far too ruthlessly in the past. The work of Rosenow, the observations of Hunter, Murphy, Billings, the Mayos, Crile, and others of the medical profession, and the investigations of Grieves, Rhein, Gilmer, Price, Logan, Moorehead, Hartzell, Lyons, Marshall, Rickert, Endelman, and others of our own profession, along the line of periapical infections and the systemic results, should teach us to conserve the dental pulp in every case where it is practicable and consistent with good dentistry. Thousands upon thousands of normal pulps have been sacrificed for no other reason than that the dentin of the tooth was hypersensitive. When we think of the difficulty—not to mention the carelessness—under which these pulps are often removed, and of the frequent periapical infections resulting therefrom, we behold a sad spectacle, indeed!

I have never heretofore, nor do I intend now, to plead for the life of the pulp when the reading of the clinical symptoms clearly indicates its removal; but I do mean to say that in all cases an effort should be made to determine as nearly as possible the exact pathologic condition, and our decision should be based upon these findings. From the viewpoint of the diagnostician there are few subjects of greater importance than those of hyperemia and inflammation of the dental pulp.

Diagnosis of Active and Passive Hyperemia, and True Pulpitis.—In the pulp tissue, as in all living tissues of the body, we may have two kinds of hyperemia—active, or arterial, and passive, or venous. The former is defined as an excessive amount of blood in the arteries and the latter as an excessive amount of blood in the veins. Active hyperemia is due to a determination of blood to a given part as the result of reaction to an irritant, and as long as it remains without an excessive immigration of the white blood corpuscles, it is active, or arterial hyperemia. The cause of passive hyperemia is different. Here the blood may be held back by some obstruction in the veins which prevents the return of blood to the heart. Inglis says: "The backing up of the blood following venous obstruction produces tension upon the vessels, followed by diapedesis of red corpuscles and exudation of watery fluid—the condition of edema. In inflammation arterial hyperemia appears as the first stage, followed by a collection of leucocytes along the walls of the small veins, and the immigration of some into the perivascular tissue. As this eventually leads to stoppage of the blood current, and even to stasis, the condition is essentially a venous hyperemia. Accompanying the immigration of leucocytes is an exudation of lymph, highly coagulable in character, which distends the lymph spaces in the tissue and produces the characteristic swelling."

The thing of special interest here is that in inflammation or even in venous hyperemia certain blood elements escape through the temporarily dilated vessels into the perivascular tissue, which becomes coagulated, and when the tissue involved is the dental pulp, which, even though now believed to possess lymphatics, is nevertheless confined within a cavity having unyielding walls, this coagulation of the fluid elements of the blood means death. The procedure of many practitioners when an aching tooth presents involving the pulp is simply to find out whether the latter is dead or alive. If alive, cocain hydrochlorid or arsenic trioxid is generally applied, or else the tooth is treated tentatively by placing cotton dipped in oil of cloves or some other soothing remedy in the cavity, and the patient is dismissed without making any effort to ascertain the condition of the pulp—whether it is in the stage of active hyperemia or passive hyperemia or true inflammation. If, on the other hand, the pulp is found to be dead, the tooth is too frequently treated by opening up the pulp chamber and placing therein a pledget of cotton dipped into the most convenient remedy at hand, leaving the cavity unsealed for fear of causing septic pericementitis or an acute alveolar abscess, and making no further effort to ascertain whether the pulp

has been infected by pyogenic microorganisms, producing pus on the exposed surface or, as sometimes occurs, within the substance of the tissue, or whether the germs inaugurating the changes are of the saprophitic variety causing pulp decomposition with gaseous end-products. It is highly essential, therefore, when a patient presents with an aching tooth, that we take the time and trouble to determine not only whether we have a live or a dead pulp with which to contend, but, if the pulp is alive, whether the condition is one of active hyperemia only or passive hyperemia or inflammation; or, if the pulp is dead, whether the condition is a so-called septic pulp with pus formation (pulpal abscess) or one of true gangrene with gaseous end-products. To confirm our diagnosis the tooth should be isolated and kept dry, preferably with the rubber dam, and a careful examination made. On no other basis can rational therapeutics be practised.

Differential Diagnosis.—It is generally a simple matter, by asking a few questions and observing conditions, to differentiate between the pathologic conditions of a vital pulp sufficiently to determine whether the pulp had better be saved or destroyed. In acute active hyperemia the pain occurs only when the irritant is applied, and subsides almost momentarily without treatment. Logan states that "active hyperemia exists in a pulp when the pain begins with a known irritation, lasting only a few moments, or minutes at the most, and subsiding without treatment and not starting again until the application of another known irritant is made."

Treatment of Active Hyperemia.—The treatment of this condition consists in protecting the tooth from the irritant which caused the disease. If a cavity exists which is causing the trouble an anodyne remedy is indicated. One treatment with phenol compound, or other remedies possessing similar properties, should cure a case of active hyperemia due to caries of the tooth. At the second sitting, if the case has a favorable history, the rubber dam should be adjusted and the dressing and carious dentin removed, after which dentinoid should be placed immediately over the pulp when a base of cement may be inserted, the cavity prepared, and the tooth filled. In those cases where the cavity is deep and encroaches upon the pulp, and where the removal of the softened dentin practically or actually exposes the organ, it is necessary, in order to save the pulp, to cap and protect it. This brings us to a consideration of pulp capping.

Factors to be Considered in Pulp Capping.—There are several important factors to be considered, and upon these will largely depend the success or failure following an attempt to save the pulp

after it has actually been exposed. In an accidental exposure in the preparation of a cavity, the chances of saving the pulp, provided the injury has not been too great, are far more favorable than if the pulp had been exposed by the necessary removal of the carious dentin. Our success will also depend in no small degree upon the condition of the pulp as well as upon the general condition of the mouth of the patient in which the exposure occurs. In cases of hyperemia of the pulp an effort should be made to determine whether it is active or passive hyperemia, and where pulpitis is present our prognosis will be governed largely by ascertaining whether the pulpitis is partial or complete, or of the nonseptic or septic variety. If there is congestion or any evidence of degeneration of the structural components of the pulpal organ itself, it would be futile to attempt to cap it. Logan is of the opinion that most pulps, the exposure of which has been brought about by caries, have undergone sufficient inflammatory changes to cause their ultimate death, even when carefully capped. Any attempt to permanently save an exposed pulp in the mouth of a patient who is suffering from some systemic derangements interfering with the general circulation, thus lessening vital resistance, would doubtless result in failure also, for in such cases the pulp would fail to receive from the blood supply the necessary elements for the restoration of its functional activity. The general condition of the mouth itself and the care it receives daily from the patient, are essential factors to be taken into consideration before proceeding to cap a pulp; for Hopkins, of Boston, in a carefully conducted series of experiments to ascertain the difference in virulency of certain pathogenic bacteria in different mouths, and in the same mouth under differing conditions, proved that not only did the germs proliferate more rapidly in neglected and uncared-for mouths, but their pathogenic properties were greatly increased.

Exceptional Cases of Exposure.—There is one class of cases of pulp exposure which frequently present in a busy practice and in which it is our plain duty to make the attempt to restore the organ to its normal function, even though the conditions for doing so are not altogether favorable. I mean here those cases in the mouths of young patients where the pulp is exposed from decay or accident and the roots of the tooth have not been fully developed. Every effort should be made to cap such a pulp, provided the clinical symptoms are at all favorable, and thereby save it, if for only a year or two; for experience has demonstrated that to remove the pulp and properly close the large openings in the ends of the roots is, at best, a difficult

procedure; that a tooth in this condition, thus treated, is usually a source of infection and its usefulness generally of short duration.

In another class of cases the author also believes that we are justified in capping the pulp. For instance, in those cases of exposure where for certain reasons it is desirable to save the tooth, and on which it would be difficult to adjust the rubber dam, aseptically remove the pulp, and thoroughly fill the canals. I wish to state here, however, that I do not mean to infer that a pulp should be capped in an anterior tooth, because of the liability of the tooth-structure discoloring after the pulp has been removed. This phase of the subject will be referred to in detail subsequently under the Preservation of the Color of the Tooth in Pulp Removal.

From the foregoing, then, it should readily be understood that no set of rules can be given, the application of which will surely lead to success. Every case must be studied and treated according to the pathologic conditions found and the operator's best judgment, after having taken into consideration all these various factors.

Therapeutics of Pulp Capping.—There are several methods of capping the pulp, each differing in minor details, such as the use of various cements, gutta-percha, concave metallic disks, etc., etc. The reader's attention will first be directed to the general precautions to be taken in following the different methods of capping; after which one method will be described in detail which has proved successful in the author's practice. By this I do not mean to convey the idea that all pulps which I have attempted to save have been rehabilitated to their functional activity—many have not; however, a sufficient number of those thus treated have remained quiet, and proved years later to be vital, to justify making the attempt where the case demands it.

Precautions.—The precautions to be observed in following any method are:

1. By the use of an anodyne, the hyperemic pulp, if in this condition, *must be restored to normal* before the final capping.

2. The dentin overlying the pulp *must be thoroughly sterilized.* It should be noted here that the usual perfunctory method of sterilizing the dentin by simply applying a germicidal solution to the cavity for a few moments does not sterilize to the degree necessary for successful results. The lack of thorough sterilization has, without doubt, been the chief cause of failure in many instances. The accuracy of this statement will be seen when we remember that our greatest success has followed the capping of pulps which have been accidentally exposed with a bur or instrument in preparing a cavity,

although, in most cases, greater mechanical injury had been caused than when the exposure was due to caries or the removal of carious dentin.

3. Pressure in applying the material for capping, or the cement which covers the capping, *must be avoided.*

Technic.—After breaking down all overhanging edges of enamel and removing as much of the débris and softened dentin as can be done without pain or injury to the pulp, the cavity should be flooded with a mild, nonirritating, antiseptic solution, previously heated to the temperature of the body. For this purpose the author suggests the use of one of the following remedies:

℞—Phenolis, f℥ss (2.0 cc.)
Aquæ menthæ piperitæ, f℥vj (180.0 cc.)—M.
Sig.—Use wherever a mild, nonirritating, antiseptic solution is indicated.

℞—Alcoholis, f℥j (4.0 cc.)
Aquæ cinnamomi, f℥vj (180.0 cc.)—M.
Sig.—Use as a spray.

These solutions can be used as a spray or with a water syringe before applying the rubber dam, thus adding comfort and cleanliness to the operation. The excess can now be absorbed from the cavity with cotton and the dam adjusted. By using some obtunding remedy and a sharp spoon excavator, or oftentimes a large round bur in the engine, the carious dentin can be removed. If, however, the thorough removal of all the discolored dentin would make a large exposure, it is best to leave the layer overlying the pulp and depend upon the sterilizing agent, rather than to jeopardize the life of this organ by the injury thus produced. The delicate pulp tissue will not tolerate much abuse and remain quiet, therefore, if it is injured to any great extent it had better be removed at once. The dentin can now be sterilized by sealing in the cavity, for a few days, the following remedy which is not only germicidal in action, but possesses marked anodyne properties as well:

℞—Mentholis, gr. xx (1.3 Gm.)
Camphoræ gr. xl (2.69 Gm.)
Phenolis, (U.S.P.) f℥iij (12.0 cc.)—M.
Sig.—Use as directed.

For convenience this remedy has been called *phenol compound.*

It is best to seal with a veneer of quick-setting cement, previously filling most of the cavity with cotton, thereby avoiding pressure and facilitating the subsequent removal of the dressing. By this means

the dentin can be thoroughly sterilized, and the pulp, if at all hyperemic, as it is likely to be, will return to its normal condition.

Thymol has a peculiar but favorable action on animal tissue and for this reason it was formerly incorporated in the above prescription. The later formula for phenol compound contains camphor instead of thymol, which enhances the anodyne property of the remedy; thymol being a constituent of the capping and protecting material. At the next sitting, the case giving a favorable history for the interim, the dam should always be applied, the teeth included sterilized, and the previous dressing carefully removed, when the exposure and dentin immediately over the pulp can be gently covered with a thin paste made by mixing *thymolized calcium phosphate* with oil of cloves or eugenol. A prescription for the thymolized calcium phosphate follows:

℞—Thymolis, gr. x (0.6 Gm.)
Calcii Phosp. ppt. (purificata), ℥j (32.0 Gm.)—M.
Sig.—Use as the powder for making paste.

The paste should be placed on one side of the cavity and gently coaxed over the exposure in such a manner as to exclude the air. I desire to emphasize the importance of covering the entire dentin immediately over the pulp, as well as the exposure, with this antiseptic and nonirritating paste. By this means we prevent the phosphoric acid of the cement, used to cover the paste and to temporarily fill the cavity, from irritating the pulp. It should be understood that this paste is only intended as a nonirritating, antiseptic covering for the pulp. *It does not set.* To bring about "setting," it would be necessary to use a substance for the powder and an acid for the liquid which react upon each other. This would cause irritation, thus defeating our object. It is best, as intimated here, to fill the entire cavity with cement and wait for a few months or perhaps a year before inserting the permanent filling or inlay; and even then we should be certain that the vitality of the pulp has been retained, for frequently exposed pulps, under the most careful treatment, gradually die without any objective symptoms. The fact that the tooth has given no trouble should not be taken as evidence that the pulp is alive, for the reverse is too often true—the drugs in the capping material keeping the tissue, though dead, from undergoing decomposition for months and sometimes for years.

Every advantage should be taken to prevent all possible means of subsequent irritation to the pulp. For this reason the author uses precipitated calcium phosphate instead of calcined zinc oxid, which

latter substance is recommended by many writers. The powder (largely zinc oxid) which comes with a package of cement is supposed to be chemically pure. Those who are familiar with the science of chemistry, however, know that arsenic is found associated in Nature with many of the metals, among which is zinc; and, while it can be done, it is difficult to obtain these metals or their oxids free from arsenic. It is well in those cases where the pulp is not quite exposed, to add a small amount of either *aristol* or *europhen* to the paste. These are iodin compounds and are used as substitutes for iodoform. They act as a mild stimulant to the pulp, thus causing secondary dentin to be deposited, when we have Nature's protection. Both are tasteless, practically without odor, and insoluble in water, but soluble in the *oil* used as the vehicle for the paste; therefore, only a small amount should be added, for it is possible to overstimulate the pulp, with the result of bringing about a *pathologic* rather than a *physiologic* condition.

The practice of dentistry today requires that every effort should be made to save the dental pulp and keep it in a healthy condition. With this thought in mind and following the line of suggestion in the preceding paragraph, the author has recently developed a new product, called Dentinoid,[1] for *protecting the tooth pulp* and *filling the canals of pulpless teeth.* It is an artificial dentin containing calcium phosphate and stimulating antiseptics (see page 212); and is a nonconductor and absolutely nonirritating, and as nearly permanently antiseptic as a remedy or material of this kind can possibly be. The antiseptics used are insoluble in water and are stimulating in character; thus when the product is used for protecting the dental pulp in deep-seated cavities, it not only sterilizes the dentin immediately over the organ, but encourages the deposition of secondary dentin by stimulating the odontoblastic layer of cells, thereby bringing about Nature's protection. When Dentinoid is used for filling root-canals, it likewise keeps the canal and dentin sterile and tends also to stimulate the cementoblasts which, it is believed in time will completely cover the foramina as the subsequent lamellæ of the cementum are formed, when again we have Nature's protection. In cases of pulp exposure there need be no hesitancy in placing the material directly over the exposure; if, in the judgment of the operator, the pulp is healthy and can be saved by proper treatment and protection. If the pulp is normal it will scarcely ache when Den-

[1] NOTE. Dentinoid is a powder. When used the desired amount should be transferred to a glass mixing slab and just enough alcohol added by drops from a medicine dropper to make the mix. Excessive spatulation is unnecessary.

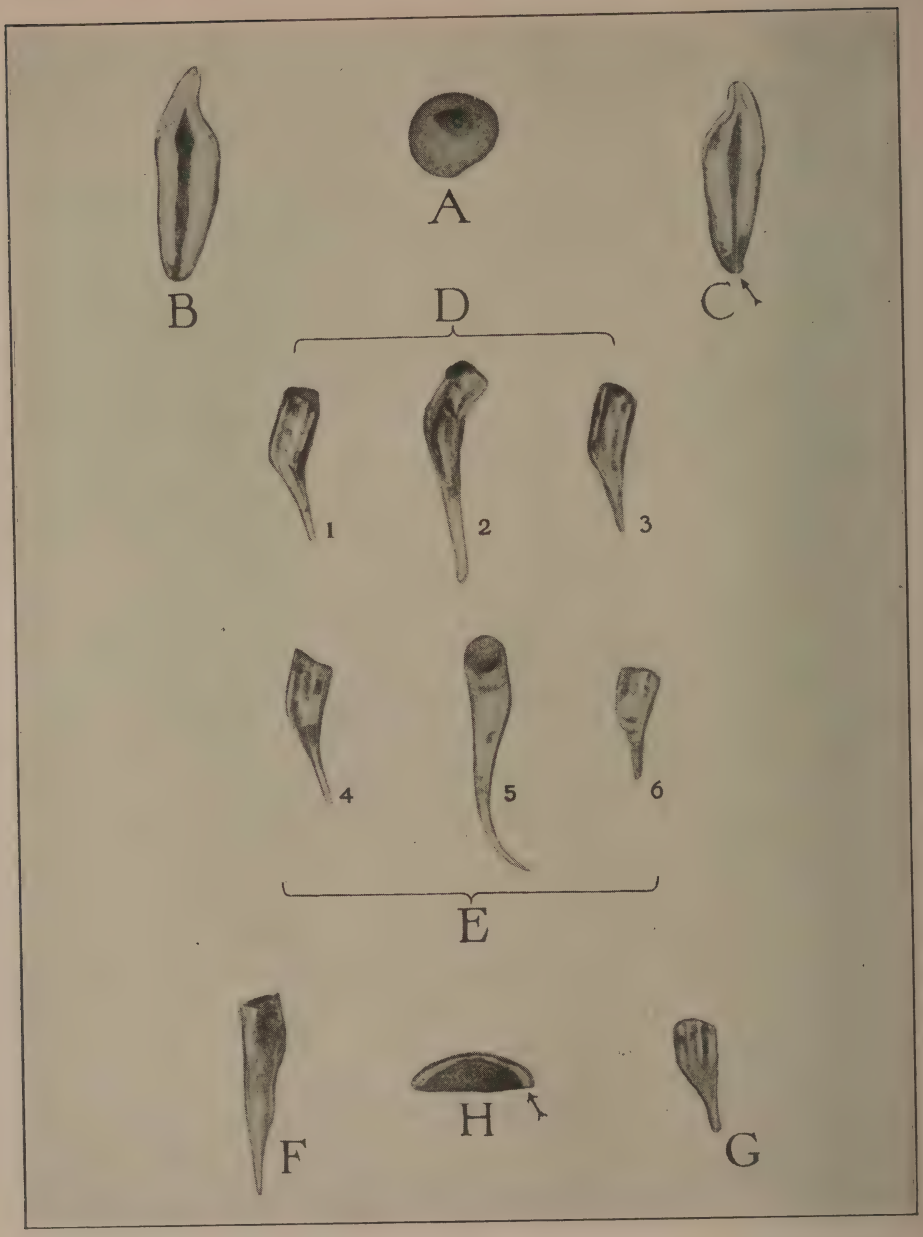

FIG. 24.—A—Dentinoid mixed with alcohol. B—Root-canal of an extracted tooth filled with Dentinoid and gutta-percha points—the latter being held in chloroform a few moments before packing. C—Same as B, except the gutta-percha points were dipped in thin eucapercha before packing. The arrow shows a fine white line of Dentinoid at the apex and at the side of the gutta-percha, extending upward along the canal—sealing the tubuli and filling all spaces not filled with the gutta-percha. D—1–2–3—Glass "canals" filled with Dentinoid and gutta-percha, dipping the latter in chloroform. E—4–5–6–Same as D, except eucapercha was used to moisten the gutta-percha points. F—Glass "canal" filled with Dentinoid, apex of canal closed. G—Same as F, except apex of canal was open and rather large. H—Dentinoid mixed with alcohol, permitted to set over night, and then dropped into staining fluid (ink) for six hours. The arrow shows the hard, resistant surface which has not been penetrated by the staining fluid. In actual practice this is the material which adheres to the tooth structure and seals the tubuli. (See Clinical Observations, page 481.)

tinoid is thus applied. For safety and protection this material should be placed in every deep-seated cavity immediately over the pulp, thus practically replacing the same material as has been destroyed by the carious process. In contradistinction to the paste formerly recommended for this purpose, Dentinoid when mixed with alcohol *does set.* In the mixing process the alcohol dissolves the resinous binder, forming a varnish which, when the liquid evaporates or is taken up by the tooth structure, firmly binds the particles of calcium phosphate into a hard, compact mass—thus the pulp is protected by an *artificial dentin* containing, as has been stated, stimulating antiseptics. In those cases where a considerable amount

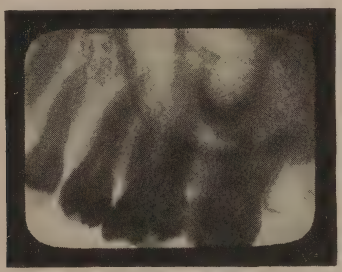

FIG. 25.—(C. E. B.) This patient, age 20, had white decay under a cement filling in the upper left first molar. In removing the decay the mesiobuccal horn of the pulp was exposed. Dentinoid was used at once, placing it over the exposure and dentin immediately over the pulp. The remaining cavity was again filled with cement, which, after fourteen months, was replaced with a gold inlay. The pulp responding to every test for vitality at the time. At this writing, two years later, the pulp is still vital and the tooth comfortable.

of Dentinoid has been used in protecting the pulp in a deep-seated cavity and where it is necessary to subsequently drill into the material, thereby removing the hardened surface, it should be coated with a varnish made by dissolving resin in chloroform. This hardens the exposed surface and leaves it as it was before the drilling was done. (See clinical observations, page 481.)

The author desires to emphasize the importance of studying carefully the conditions as found in each case; and to say that the opportunity here for exercising good judgment is very great, and that there is a satisfaction in realizing, whether we succeed or fail in our efforts to save the pulp, that we did our duty as we saw it.

Treatment of Passive Hyperemia and True Inflammation.—As far as therapeutics is concerned, it is of little importance to know whether the pathologic condition of the pulp is passive hyperemia or true inflammation. In either case we have transudation of the fluid elements of the blood and diapedesis of the red corpuscles

occurring, and this means death ultimately. In passive hyperemia the pain is more constant than in active hyperemia, and may start without the application of a known irritant. In inflammation the pain is continuous and of a boring character, or it may be lancinating, and is frequently described by the patient as a "jumping toothache." When the reading of the symptoms indicates either of these conditions, our therapeutics differs from that prescribed for active hyperemia, for here, as has been previously stated, the pulp must be destroyed.

THE REMOVAL OF VITAL PULPS AND SUBSEQUENT TREATMENT

GENERAL CONSIDERATIONS

Embryologists claim that when the roots of a tooth are fully developed, the pulp has no further function to perform. If this theory can be accepted as correct, and I think that it is quite well established, it would appear from the large percentage of failures following the most careful methods of pulp capping that the safest and, therefore, the best practice would be *to destroy the vitality and remove the pulp* in all cases where this delicate and susceptible tissue has been previously irritated for any great length of time, unless, as explained under Exceptional Cases of Exposure (p. 355), there is some special reason for attempting to restore the organ to its functional activity. From sad past experience the author has been led to adopt this general practice. By this I do not wish to convey the idea that it is advisable or necessary to injudiciously or ruthlessly destroy pulps, for this is not the case. As has been previously emphasized, it is the plain duty of every dental practitioner to save the pulps of teeth, if it can be done with any reasonable degree of success. There are many conditions, some of which are pathologic and others are not, which necessitate the removal of the pulp, such as:

1. *Dental Caries.*—In those cases where dental caries has encroached upon the pulp to the extent of producing passive hyperemia or true inflammation, especially the latter disease. The pulp here oftentimes has been invaded by pathologic bacteria, and frequently the tissue has absorbed poisonous ptomains or toxins. This is, perhaps, the most prolific source of pulp irritation.

2. *Mechanical Irritation.*—This is due to such causes as abrasion, thermal changes, close proximity of metallic fillings, injudicious regulating, excessive grinding, etc.

3. *Calcific Deposits.*—This includes pulp nodules, partially calcified pulps, and secondary dentin. These calcific deposits result from slight but continued irritation of the pulpal organ.

4. *Crowning Teeth and Filling Large Cavities.*—It is usually difficult to grind a vital tooth sufficiently to properly adjust the band for a crown, or prepare a tooth for a porcelain jacket, without irritating

the pulp and thus endangering its life. This preparation can be made successfully, but it requires care and judgment, if pulp trouble is not to follow. Sometimes in filling teeth it is advisable to remove the pulp in order to properly anchor a large filling or inlay. Here again judgment is essential and this should only be done in exceptional cases. With the newer methods of filling and crowning teeth, as well as anchoring attachments for bridges, there is seldom need for removing a healthy pulp.

5. *Periodontoclasia.*—Frequently in treating this disease, where the teeth are acutely sensitive or where the pockets are deep and the infection in the apical area has left the pulp in a low state of vitality, the best results can be accomplished by removing the organ, and surgically eradicating the pocket. Generally, however, the sensitiveness may be overcome by other means; and, in the latter instance, the safest practice would probably demand the tooth removal.

General Factors to be Observed in Removal of Pulp.—Having considered all of the conditions and decided that the removal of the pulp is indicated, the method by which this can be accomplished with the least inconvenience to the patient and to the operator is the most important consideration. Whatever method is employed in the removal of pulps from teeth and the subsequent treatment, there are at least three factors to be observed, viz.:

1. Establish and maintain asepsis in performing the operation.
2. Preserve the color of the tooth.
3. Thoroughly fill the root.

There are two general methods employed in the removal of pulps —*anesthetization* and *devitalization.*

I. ANESTHETIZATION

In the author's opinion a method of removing pulps from teeth, which is satisfactory to both patient and operator, all things considered and conditions being favorable, is to anesthetize the tissue by the use of local anesthetics in solutions of various strengths. The solutions are forced or carried through the dentin and into the pulp by means of pressure or the electric current. In exceptional cases conduction or interosseous anesthesia may be employed; and many practitioners are now using these methods, especially conduction anesthesia, as a general practice for pulp anesthetization.

1. PRESSURE ANESTHESIA.—By pressure anesthesia is meant the process of anesthetizing the pulp by forcing solutions of local anesthetics into the tissue by means of pressure. The pres-

sure is applied either by using unvulcanized rubber or gutta-percha and a blunt instrument, or by specially devised instruments for this purpose. There are many such instruments on the market; and while they are often an aid in accomplishing the ultimate result, they are not an absolute necessity.

Sterilization.—The rubber dam should be employed in every case where it is possible to adjust it, and the teeth included sterilized. In cases where the dam cannot be adjusted, it would doubtless be best to remove the pulp by the devitalization method, to which reference will be made later, for in using the method under consideration care must be taken to prevent pericementitis following the operation; and one of the precautions to be observed in preventing this result is to *thoroughly sterilize* the cavity before applying the pressure. It should be remembered that the majority of canals which contain live pulps are sterile, generally speaking, and if they become septic at any time before the root is filled, it is the fault of the operator; hence the importance of always adjusting the rubber dam, using sterile instruments, and having in a convenient and conspicuous place an antiseptic doily on which to wipe the blood and dry the instruments used.

Attention is again directed to the fact that the usual custom of applying coagulating agents, such as phenol, cresol, etc., to the cavity for a few seconds does not sterilize the dentin to the degree desired. The best results are accomplished by employing germicidal agents which are soluble in water. In cavities where the decay is not too deep, the dentin can be sterilized by the use of a 10 per cent. solution of formaldehyd to which 5 per cent. of sodium borate (borax) or sodium carbonate has been added. Where the decay is near the pulp this solution is liable to cause pain, in which case the same result can be accomplished by the use of a 1:500 solution of mercury bichlorid or a 1:200 solution of sublamin. In using the latter solutions the pliers on which the remedy is applied should be wiped immediately on an antiseptic doily to prevent the mercury from acting upon the instrument. A 5 per cent. solution of dichloramine-T may also be used, observing the precautions elsewhere mentioned in connection with the use of this agent. One of the best solutions with which to chemically sterilize the dentin, especially in those cases where the cavity has previously been filled, the tubuli are closed, and, perhaps, there is secondary dentin, is a 25 per cent. solution of sulphuric acid. Cook recommends using pure sulphuric acid for this purpose. The solution can be applied to the floor of the cavity, being careful not to get the agent on the crown of the tooth. After a few minutes the

excess can be neutralized with a solution of sodium bicarbonate. After the dentin is sterilized the cavity should be desiccated with warm alcohol and gentle heat, when we are ready to use the anesthetizing solution. Before taking up the technic of this method, however, I desire to again emphasize the importance and necessity of cavity sterilization. In our discussion later of the devitalization method, it will be pointed out that the carious and infected dentin can be completely and painlessly removed after the devitalizing agent has been applied, thus *mechanically* sterilizing the cavity; but in the anesthetization method the infected dentin is sensitive and cannot be removed without unnecessarily producing pain. The dentin in this case must, then, be sterilized by *chemic* means, for to force the anesthetizing solution through the dentin without previously sterilizing it, means the forcing of microorganisms and, perhaps, poisonous ptomains or toxins, into the pulp tissue and many times into the tissue surrounding the apical end of the root, for it is difficult to force the solution to, and only to, the apex; thus too much pressure and the lack of thorough sterilization constitute a prolific source of pericementitis following the removal of pulps by this method. For the same reason, a pulp which is exposed by caries, and, therefore, undoubtedly infected, had better not be removed by pressure anesthesia.

The Solution.—With the cavity thoroughly sterilized we are now ready to use the anesthetizing solution, which should be made at the time. For this purpose the crystals, previously powdered, or flaked cocain hydrochlorid or procain hydrochlorid should be used as the base, and freshly distilled or boiled water as the vehicle. In my own practice I use "cocain points," which are compressed points or cylinders of pure cocain hydrochlorid containing $\frac{1}{12}$ grain (0.005 Gm.) each, as the base and my regular local anesthetic solution as the vehicle for making the stronger solution. A prescription for the regular local anesthetic solution here follows:

℞—Cocainæ hydrochloridi,	gr. v (0.3 Gm.)
Sodii chloridi,	gr. j (0.06 Gm.)
Phenolis,	m. ij (0.13 cc.)
Aquæ menthæ piperitæ,	f℥j (30.0 cc.)—M.

Sig.—Use as a local anesthetic for hypodermic injections.

"Procain points," each containing $\frac{1}{12}$ grain (0.005 Gm.), may be used in the same manner. There are many advantages in using the anesthetic agent in cylinder form. The exact amount of the drug used is known, the points are readily soluble and, in many cases, they can be conveniently placed in the sterile cavity and dissolved

therein, either in the serum of the blood, if an exposure exists, or in the vehicle used for this purpose. There is no advantage in using the above solution rather than distilled or boiled water or freshly prepared peppermint water, except that the solution is always at hand in a convenient container and is sterile. Sterile physiologic salt solution is an excellent vehicle for making the anesthetic solution.

The thumb and forefinger with which cotton is to be wrapped around the broach should be sterilized by dipping a large pledget of cotton in 10 per cent. formaldehyd, or 1:500 mercury bichlorid, or 1:200 sublamin solution, and rolling this between the thumb and finger. A "point" or a small amount of powder or flaked crystals of the selected anesthetic is now placed on a clean glass slab and a pledget of cotton, dipped in the vehicle selected, a few drops of which have previously been placed on one end of the glass slab or in a clean glass watch-crystal or other container, is gently placed in contact with the alkaloidal salt, when the latter readily dissolves, making a strong solution. It is never necessary to make a saturated solution, for oftentimes better results will be obtained, especially if the solution is to be forced through the dentin, if the strength of the solution approximates only 4 or 5 per cent. If an exposure exists, as stated above, the "point" can be placed directly in contact with the pulp and be dissolved in the blood-serum.

Pressure.—The cotton thus saturated is placed in the cavity as nearly over the pulp as possible. A piece of unvulcanized rubber which will approximately fill the cavity is selected and passed through the flame. There are two objects in doing this: It sterilizes the rubber and also makes it more pliable, in which form it conforms readily to the cavity of the tooth. The rubber is now placed in the cavity, and by means of gentle but firm pressure with a suitable blunt instrument the solution is forced through the dentin and into the pulp. If there is any evidence of pain as the pressure is applied, it should be stopped for a moment, but never released. The slight pain is only momentary and is an indication that the solution is being confined under the pressure, which is essential for the success of this method.

It may be necessary in those cases where there is considerable dentin between the cavity and the pulp to make two or three applications before the pulp is reached without pain, after which one application should complete the thorough anesthetization of the organ. After the first application a small depression can be drilled into the dentin toward the pulp, in which the solution can subsequently be placed, thereby aiding materially in confining the solution under the pressure.

When an exposure exists, it requires but little pressure to anesthetize the pulp. In these cases the "point" can be placed in the cavity near or over the exposure and the pulp gently pricked with a sharp explorer, causing it to bleed; this, if done carefully, will produce very little pain. The blood-serum will dissolve the anesthetic agent, when pressure can be applied and the pulp anesthetized. In doing this, however, there is greater danger of forcing the blood into the tubuli of the dentin of the crown of the tooth, thereby making it more difficult to remove the blood. Care should also be taken not to force the solution any further than is necessary for the painless removal of the pulp, and it should here be again noted that cocain is a general protoplasmic poison, and if even weak and sterile solutions are forced past the apices of the roots pericementitis is almost sure to follow. This is true to a larger degree no matter what anesthetic agent has been used.

Confining the Solution Under Pressure.—In removing pulps by pressure anesthesia without employing instruments devised for this purpose, the best results are obtained in cases where there are four walls to the cavity, for in this condition the solution is easily confined under the pressure. In proximo-occlusal cavities, the missing wall can be built temporarily with gutta-percha or cement. This is seldom necessary, however, if, in packing the rubber in the cavity, care be taken to cover the gingival wall first and thus seal at this point, then working the rubber over the occlusal and gradually creating the pressure. Whatever means are adopted for the purpose of confining the solution, we must avoid having the solution escape at the gingival margin of the cavity and thereby be forced into the gum tissue and pericemental membrane. The cause of much pericementitis following this method of removing pulps can be traced to carelessness or ignorance in this regard.

As stated elsewhere, there are many ingeniously devised instruments on the market, the use of which is often a material aid in confining the solution under pressure and forcing it through the dentin. The same precautions should be observed in using any of these instruments as have been emphasized in the application of pressure by other means.

Opening the Pulp Chamber to Expose Canals.—When the pulp is anesthetized, the pulp chamber should be opened into in such a manner as to expose the canals. This is best accomplished with a large round or inlay bur by means of which the entire roof of the chamber can be obliterated. A bur suggested by the author for this purpose is simply a large inlay bur with the end rounded. In opening

into the pulp chamber of the molar teeth care should be taken not to disturb the floor or walls of the chamber; for by so doing we are liable to drill through the bifurcation or the mesial or distal surface of the roots. Even if such disastrous results do not follow the destruction of the floor or walls of the chamber, it at least adds to the difficulty of entering the canals with a broach. (See Fig. 26.) While we are never justified in drilling unnecessarily for the purpose of freely exposing the canals. it is, if necessary, far better to weaken the crown of the tooth somewhat by this means rather than leave a portion of the pulp in an inaccessible canal which may decompose and subsequently cause an infection in the periapical area.

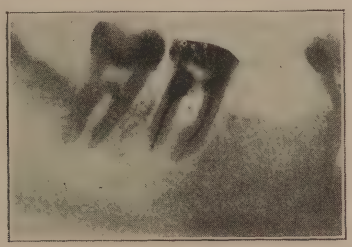

FIG. 26.—This radiogram shows that the dentist, in opening into the lower first molar, drilled through the floor of the pulp chamber and exposed the tissue between the bifurcated roots; and, as a result, an abscess subsequently developed. The case was treated by sterilizing and stimulating the necrotic area between the roots with phenol-sulphonic acid, subsequently flowing eucapercha compound over the puncture and packing firmly with warm base-plate gutta-percha. The practice today demands the removal of all such teeth. The cut is retained in this edition as a caution against carelessness in opening into pulp chambers.

Selecting and Testing Broaches.—The selection of a proper broach is an important matter. Every broach should be tested before entering the canal. This can be done by bending it in various directions. If the broach is weak in any particular place it can be detected by this means; thus we avoid breaking the broach in the canal, the removal of which is often a difficult procedure. Many good operators claim to be able to remove all pulps by using a smooth, three-cornered broach on which a few threads of cotton are wound. Others use twist or spiral broaches. In all large canals the author has had the most satisfaction from the use of a barbed broach. The broach should be gently worked along the side of the canal as far as it will go without using too much force, twisted once or twice to entangle the pulp, and then withdrawn. By this means the pulp can be removed from large canals in its entirety. In inserting the broach into the canal, care should be exercised to avoid pushing the tissue before the broach and thus pack it into the apical area, where it

is difficult of removal. Many root-canals have been imperfectly filled and abscesses subsequently developed, because of the failure to remove all of the pulp tissue at the time it was anesthetized or devitalized.

Control of Ordinary Hemorrhage and Removal of Blood.—In the removal of live pulps by the anesthetization method, there necessarily will be more hemorrhage than in those cases where the pulp is devitalized before attempting to remove it. However, the control of hemorrhage is not as difficult a procedure as many writers have led us to believe. In most cases the hemorrhage, if undisturbed, will be checked by Nature's method in a few minutes, after which the blood in the cavity and canal should be *thoroughly removed.* I desire here to emphasize the importance of *removing the blood.* One of the factors to be observed in extirpating pulps from teeth and the subsequent treatment, is to *preserve the color of the teeth.* The cause of many teeth darkening after the pulp has been removed can be traced directly to the failure to remove the blood from the dentin of the crown of the tooth. The far too prevalent practice of wiping out the bloody canal with a solution of hydrogen dioxid, blindly thinking the blood can be removed by this means, cannot be too strongly condemned. The hydrogen dioxid simply decomposes the blood within the tooth-structure, oxidizing the iron of the hemoglobin; and the gases evolved in the decomposition force this pigment into the tubuli, which, if left (and it is difficult to remove it), will cause the tooth to darken in almost every instance. Therefore, we should avoid forming within the tooth-structure a pigment which we know will discolor teeth. *The color of a tooth does not depend upon the life and vitality of the pulp, but upon the array of colors in the dentin which are reflected through the nearly colorless and transparent enamel.* If, then, these colors are not changed by our failure to remove the blood or by the use of staining remedial agents in the treatment subsequent to pulp removal, the tooth will not discolor.

To remove the blood from the canal, alcohol can be used, or even better than this agent is Nature's greatest solvent, water. The water should, of course, be sterile, and the same specimen can be employed here as was used in making the anesthetizing solution, *i.e.*, freshly distilled or boiled water, or peppermint water to which two minims (0.12 cc.) of phenol have been added to the fluidounce (30.0 cc.). Sterile physiologic salt solution is perhaps the best solution to use for this purpose. By this means the blood can be completely *removed*, not decomposed in the canal and forced into the structure of the tooth.

Small Canals.—There are many canals so small and tortuous that even a fine broach will not readily enter, to any depth at least. In these cases, after the hemorrhage from the larger canals has been checked and the blood removed it is well to stop the mouth of each with cotton or temporary stopping, when the pulp tissue in the small canals can be disorganized by the use of strong solutions of mineral acids or alkalies. The author formerly used a paste of sodium dioxid and dehydrated (absolute) alcohol, placing the paste in the pulp chamber over the small canals, and working it down as far as possible with a smooth broach. The alcohol gradually evaporates, when the sodium dioxid can be decomposed into oxygen and caustic soda by placing a pledget of cotton in the cavity moistened with distilled water. After the reaction has taken place, the alkali can be neutralized with a weak solution of sulphuric acid (2 per cent.). This process can be repeated until the desired end is attained. A more convenient preparation to use here is a saturated solution of potassium or sodium hydroxid. There are other means by which the same results can be accomplished, such as the use of phenolsulphonic acid, a 30 per cent. solution of chemically pure sulphuric acid, strong solutions of potassium or sodium hydroxid, or a mixture of metallic potassium and sodium (Schreier's paste). For reasons mentioned later under the Treatment of Pulpless Teeth, the author now uses phenolsulphonic acid. These same agents can be used to advantage for the purpose of disposing of a remnant of a pulp in larger canals. It is not safe to anesthetize this remnant by means of pressure. The only cases on record, to my knowledge, where toxic symptoms have resulted from the removal of a pulp by pressure anesthesia, followed an attempt to anesthetize a remnant of a pulp or to make a second application of the anesthetizing solution.

After-treatment.—After the pulp has been removed and the canals dehydrated with modified alcohol and heat, an *anodyne* treatment is indicated. For this purpose such drugs as phenol, oil of cloves, or eugenol can be employed. The author suggests here eucalyptol compound. In using any of these remedies, especially the last-named, it is best to insert dry cotton in the canal and then place a pledget dipped in the remedy in the pulp chamber and seal with temporary stopping and cement. The dry cotton in the canal will absorb the moisture from the apical end of the root and the anodyne remedy from the pulp chamber. There is an advantage in using the dry cotton, for it is almost impossible to completely dehydrate the canal at this sitting. If asepsis has been maintained in removing the pulp, all that is necessary is to keep the canal in this condition until

the root can be filled; therefore, only a very small amount of the remedy should be used. The tendency here is to use too much with the frequent result of a mild active hyperemia in the pericementum. This condition, of course, soon subsides, but it is always best to prevent it when possible. The purpose of sealing the cavity with both temporary stopping and cement is to insure hermetic sealing of the canal. Eucalyptol compound has no advantage here over other remedies suggested for the purpose except that, besides being an antiseptic, it also aids in the hermetic sealing. The heated stopping (good grade) is placed immediately over the eucalyptol compound dressing and it adheres firmly to the walls of the cavity; the excess is removed and the remaining portion of the cavity is filled with cement.

When to Fill Canals.—The canals should not be filled at the sitting at which the pulp has been removed by pressure anesthesia, unless there be some exceptional reason for doing so. There are many good reasons why the canal should not be filled at this sitting:

1. While it is our object to force the solution just sufficiently to anesthetize the pulp, our main object is to remove the pulp *absolutely without pain;* and it is very difficult to force the solution to the end of the root without forcing it through the apex to some extent and anesthetizing the tissue in the periapical area. With the tissue anesthetized, we would have no guide as to when the root was thoroughly filled.

2. The tearing away of the pulp from its connection at the apex causes more or less irritation, and a few days should elapse to give Nature a chance to readjust the condition. The root-filling would only serve at this time to further irritate the tissues.

3. Sometimes with the utmost care in removing the pulp, secondary hemorrhage ensues with the formation of a clot in the periapical area, causing soreness, in which case greater comfort can be given the patient by the proper treatment through the root-canal than simply by counterirritation or external treatment only.

At the second sitting, the case giving a favorable history, the canal should be filled, after having used phenolsulphonic acid as explained on p. 403 under Technic of Using Acid-Method.

Excessive Hemorrhage.—There are cases occasionally where Nature does not stop the hemorrhage as readily as we desire. In these exceptional cases the hemorrhage must be stopped by artificial means, even at the possible expense of producing pericementitis. Cauterizing agents are useful here. For this purpose 95 per cent. phenol or, what is still better, phenolsulphonic acid can be worked down into the canal against the injured and bleeding tissue, after which

the acid should be neutralized with a solution of sodium bicarbonate (10 per cent.) and an anodyne treatment employed as usual. Where the above treatment does not produce the desired result, cotton saturated with a fresh 1:1,000 solution of adrenalin chlorid can be placed in the canal and with unvulcanized rubber forced into the tissue beyond the end of the root. This agent should only be used in extreme cases because of the soreness and injurious effect it is liable to produce upon the tissues involved. The newer products like fibrin ferments and thromboplastics, are also useful.

Objections to the Use of Adrenalin Chlorid.—In this connection I desire to discuss the use of solutions of adrenalin chlorid as the vehicle for making the anesthetizing solution, or the use of adrenalin chlorid and cocain hydrochlorid or procain hydrochlorid tablets for anesthetizing the pulp. The adrenalin chlorid has been suggested as a means of *preventing* hemorrhage. Now, it ought to be evident to anyone who has studied this subject that, to prevent hemorrhage by the use of any styptic or hemostatic agent, it is necessary to force the agent into the tissue from which the hemorrhage comes. Therefore, to get the effect of the adrenalin chlorid in removing pulps by pressure anesthesia, it is absolutely essential that the anesthetizing solution, which also contains the hemostatic agent, be forced through the apex and into the periapical area—the very thing we have been taught, from sad experience, not to do. When we remember that the majority of pulps we are called upon to remove are those in which there is, or has been, more or less pulpitis, and when we remember also that pathology teaches that this condition is frequently associated with pericementitis, it is questionable whether or not we ought to prevent hemorrhage in removing pulps from teeth. For to permit the escape of blood from the hyperemic tissue at the end of the root is one of the best means of aiding Nature to readjust the abnormal to the normal condition. In case the primary hemorrhage has been prevented by the use of hemostatic agents, such as adrenalin chlorid, secondary hemorrhage is almost certain to follow with the formation of a clot, the absorption of which in the periapical area is an extremely slow and tedious process.

2. CATAPHORESIS.—Cataphoresis, as has been elsewhere explained, is a term applied to the process of carrying medicinal agents in solution into the various tissues and organs of the body by means of the electric current. Formerly there was a variety of cataphoric outfits on the market. To anesthetize a pulp by this means the tooth should be insulated by the rubber dam, care being taken that no moisture escapes from the gum. A small pledget of cotton saturated

with the anesthetizing solution is now placed in the cavity, the positive pole, or anode, applied to the solution, and the negative pole, or cathode, moistened with water, applied to some part of the patient's body, usually the hand, thus completing the circuit. A steady and continuous current is desired, and the perfected instruments are so devised that the amount of current can be measured. The time required to anesthetize the pulp by this means depends largely upon the density of the dentin and the perfection of the instruments used. With the pulp anesthetized, the same method of removal and of subsequent treatment is followed as in pressure anesthesia. Cataphoresis, while successful in the hands of those who mastered the technic, never became popular, largely because of the time required to accomplish the result and because of the complicated and expensive apparatus necessary.

If the method of anesthetizing the pulp be followed and the precautions observed, as detailed here, it will be found that there are few pulps which will not yield to the influence of cocain hydrochlorid or procain hydrochlorid applied directly by means of pressure. It takes time, however, to adjust the rubber dam, sterilize the cavity, remove the pulp and blood from the canal and seal in the anodyne remedy. Many times the operator is not able at this sitting to give the necessary time to complete this operation. There are cases also where the condition or the location of the tooth in the mouth is such as to favor the removal of the pulp by another method, which will now be considered.

II. DEVITALIZATION

In discussing Sensitive Dentin under the subject of escharotics or caustics, reference was made to the fact that there are many drugs belonging to this class of agents that cannot be employed in the treatment of sensitive dentin, for the reason that they are penetrating and have the same deleterious effect upon the cells of the pulp tissue as upon the dentinal fibrillæ. Some of the agents which cannot be used for allaying the sensitiveness of dentin are exceedingly valuable and are employed for the purpose of destroying the vitality of the pulp, thus aiding in its painless removal. The most prominent of these agents is *arsenic trioxid* (As_2O_3), formerly called arsenious acid. The use of this agent in the treatment of sensitive dentin was first advocated by Dr. Spooner, of Montreal, who discovered that by sealing the drug in a cavity for a few days the most sensitive dentin yielded to its influence. The fact, however, that nearly all teeth thus treated

subsequently gave trouble because of the death of the pulp and the usual sequelæ, led the profession to abandon this agent for the purpose for which it was introduced; but it has ever since been used as a means of destroying the vitality of the pulp. In fact, for years it was the only agent employed with any satisfaction.

FIG. 27.—Tooth and alveolar process exfoliated as a result of arsenical poisoning. The patient was about 9 years of age and the apices of the tooth roots were very large.

At the present time there is considerable discussion in dental literature as to whether or not the effects of arsenic trioxid when applied to a dental pulp are self-limiting. Some men of high standing in the profession are of the opinion that the drug is too destructive an agent to be used for the purpose of pulp devitalization. It seems to the

FIG. 28.—The pulp in the second bicuspid was devitalized, canal treated and filled by the author in September, 1902. The molar had been treated by an unknown dentist previous to this time. The radiogram was taken March 28, 1916, fourteen and one-half years after root-canal operation on bicuspid. Tooth has always been comfortable, and no pathologic trouble has ever been manifested. This case also demonstrates the value of pulpless teeth in the jaw when properly treated and filled.

author that these opinions are not well founded when we consider the long clinical record of the drug as a devitalizing agent. It has been used since 1836. There can be no question regarding the harmful effects of the drug when injudiciously employed. Its action is not self-limiting. Its effects are produced only after the drug is absorbed

by the tissue elements, altering or destroying their vital processes in an obscure manner. The reason why the drug may be safely employed in devitalizing the pulp of a fully erupted tooth lies in the fact that here the effects are confined to the pulp tissue, since the organ dies by strangulation at the apex due to the congestion caused by the drug when so used. Thrombosis and death of the pulp take place; and, owing to the small foramina of the tooth-root, absorption of the drug by continuity of tissue is prevented. In those cases where the apices of the roots are not fully formed the drug, if used at all, should be left sealed in the tooth only a short time. Fig. 27 shows the results of arsenic trioxid having been left in such a tooth for too long a period of time. Fig. 28 proves that the drug may be safely used if the proper precautions are observed.

The Preparation.—Much difficulty has been experienced in the use of arsenic trioxid, largely because of the uncertainty of the preparations employed. Many arsenical preparations are on the market. The white powder can be used by moistening a small pledget of cotton with some liquid, such as phenol, cresol, creosote, or oil of cloves; then by touching the cotton to the powdered arsenic trioxid, a sufficient amount will adhere which should be transferred to the cavity and sealed, preferably with cement. It is well for each operator to select an arsenical preparation with which he can obtain good results, and then this should be used to the exclusion of all others. By this means only can we become thoroughly familiar with the action of the preparation employed. The following formula is here given for those who prefer a paste:

℞—Arseni trioxidi,	℥j (4.0 Gm.)
Cocainæ,	gr. x (0.6 Gm.)
Thymolis,	gr. v (0.3 Gm.)
Lanolini,	gr. x (0.6 Gm.)—M.
Fiat Unguenta.	

Sig.—Apply a small amount to the dentin immediately over the pulp.

I wish to state here something about the pharmacy of this prescription, for, if the preparation does not work satisfactorily, it has not been properly compounded. Arsenic trioxid is the base; cocain is a local anesthetic, and when applied to the pulp produces a condition of analgesia by which the irritating action of the arsenic trioxid is without effect, and thus prevents the tooth from aching while the pulp is being devitalized. With the alkaloidal cocain and thymol, together with this amount of lanolin, a nice paste can be made with

the arsenic trioxid. The author prefers a fiber which is made from the same formula as above by thoroughly incorporating it in some fibrous vehicle. The fiber may be stained so that it will be of a different color from the ordinary cement, which is used to seal the preparation in the cavity. Such a preparation is known as "*Devitalizing Fibre.*"

Technic of Application.—In those cases of pulpitis where the tooth has ached before the patient presents for treatment, it is always the best practice to allay the pain for at least twenty-four hours before attempting to devitalize the pulp. If for any reason this cannot be done conveniently and it is deemed best to make the arsenical application at this sitting, the engorged capillaries may be relieved by administering two or three doses of nitroglycerin, letting about one hour intervene between the doses. This will also tend to mitigate the pain which sometimes accompanies the devitalization of the pulp. The pain in these cases of pulp congestion can be absolutely controlled by carefully excavating until the pulp is exposed; then apply one-half of a "cocain point" or "procain point" to the exposure, permitting the serum to dissolve the drug, after which the arsenical application may be made in the usual manner. In any case, whether the tooth has ached or not, before applying the arsenical preparation or before adjusting the rubber dam, it is best to break down all overhanging edges of enamel and carefully remove or wash out with a nonirritating antiseptic solution any food-stuffs or debris which may be in the cavity. Foodstuffs contain albumin, and if this is in the cavity of the tooth when the arsenical preparation is applied, the arsenic trioxid will act upon the albumin, forming arsenic albuminate, and thereby a certain amount of the agent is neutralized or becomes inert. As much of the carious dentin should also be removed as can be done without producing pain, for the application should be made *to a sensitive spot in the cavity*. It is never necessary to have an exposure of the pulp; and in case an exposure exists, it is just as well to apply the preparation to the dentin immediately over the pulp, rather than to the organ itself, though in using the fiber suggested here there is no logical reason why it should not be applied directly to the exposed pulp. In any event the preparation should be covered with cotton or a small metallic or paper disk to prevent pressure and also to prevent the phosphoric acid of the cement from coming in contact with the ingredients of the preparation.

Length of Time Application Should Remain.—There are at least four factors which govern the length of time an arsenical application should remain sealed within a tooth, viz.:

1. The age and general condition of the patient.
2. The general condition of the pulp itself.
3. The amount and condition of the dentin intervening between the pulp proper and the application of the preparation.
4. The climate or season of the year, strange as it may seem, influences the action of arsenic trioxid.

Taking into consideration these various factors, the arsenical preparation should remain in the cavity from one to four days. At the second sitting the rubber dam should be adjusted, the teeth included sterilized, and the cement and preparation removed, after which every surface of the cavity should be freshened with a large round bur. This not only insures the thorough removal of the arsenical preparation, which, should a portion remain, is liable to produce pericemental inflammation, but it also *mechanically* sterilizes the cavity by removing the carious and infected dentin. This is important and is an aid in *maintaining asepsis* in the removal of the pulp. In the author's judgment, this is much better practice than to depend upon a solution of dialysed iron to neutralize the arsenic trioxid.

Opening Pulp Chamber and Exposing Canals.—The pulp chamber can now be opened, observing practically the same details as were explained under the anesthetization method. Oftentimes, in the initial opening into the pulp chamber, and sometimes on entering the canal, after the application of arsenic trioxid, the patient will experience some pain. This condition should be anticipated; for the safest method of devitalizing pulps with arsenic trioxid is to leave the drug sealed in the tooth only sufficiently long to *poison the tissue*—not completely devitalize it; and depend upon the subsequent application of some remedy containing formaldehyd to complete the devitalization. For this purpose the author uses formocresol. This remedy should be left in contact with the tissue for about three days. The formaldehyd generated from formocresol not only completes the devitalization of the tissue; but it also desiccates and toughens it, which facilitates its subsequent removal. Strange as it may seem, in those cases of arsenical soreness where the arsenic trioxid had been left in the tooth for too long a period, formocresol will absolutely correct the soreness. The clinical experience of the author leads him to believe that formaldehyd acts here as a chemic antidote for arsenic trioxid. At the subsequent sitting the tissue may be removed, and phenolsulphonic acid employed to enlarge the canals and remove therefrom every vestige of organic matter, when the canals should be filled.

Objections to the Use of Dialysed Iron and Tannic Acid.—In connection with the *preservation of the color of the tooth*, under the anesthetization method the author stated his objection to the use of hydrogen dioxid for removing the blood from the cavity and canal. It is necessary here, also, to refer briefly to a well-established practice of treating teeth after the pulps have been devitalized. It is the practice of many dentists, after removing the arsenical dressing, to flood the cavity with a solution of dialysed iron, after which the pulp chamber is opened, which usually produces some hemorrhage; then, without any especial effort being made to remove the dialysed iron or blood, tannic acid in some form is sealed in contact with the pulp for a week or ten days, it being deemed advantageous to constringe and toughen the tissue by this means before attempting its removal. Let us consider the rationalism of such treatment. The pulp tissue in all large canals is sufficiently tough to be removed in its entirety, and it must be disorganized or removed piecemeal in small canals, whether it has been previously constringed or not. Hence, there is no advantage in using tannic acid, and there is a serious objection. If those who follow this practice are observing, they will notice that after removing the tannic acid dressing the pulp tissue is dark in appearance. They will also observe that many teeth thus treated subsequently discolor. The cause for this is found in the fact that tannic acid and iron, in any form, are chemically incompatible, the resulting compound being *iron tannate*, one of the most insoluble substances known to chemistry. In the presence of moisture a form of ink is produced which is a great staining agent for dentin, and one that it is almost impossible to remove by any known process of bleaching.

As has been stated elsewhere, there are cases where, for want of time or other reasons, the pulp can be removed to advantage by devitalization; however, when this method is followed tannic acid should *not* be used, and every trace of dialysed iron (if used at all, and it is unnecessary to use it) and blood should be removed with alcohol or water.

COMPLICATIONS.—In our discussion thus far of the methods of removing pulps from teeth, we have considered only favorable cases, selecting the method best adapted to the case at hand. There are many instances, however, where it is difficult to remove the pulp by either the anesthetization or devitalization method, at least until the tooth is placed in a more favorable condition.

Hypertrophied Gum Tissue.—Oftentimes in approximating cavities the decay in one or both teeth has extended far beneath the gum,

the rough gingival margin of the cavity acting as a slight irritant by which the gum tissue is stimulated, causing it to proliferate until it fills a portion of, and in some instances the entire, cavity. In such cases the first consideration is to dispose of the hypertrophied tissue. Where the gum fills only a portion of the cavity and the pulp of the tooth is not causing trouble, the cavity should first be enlarged and washed with a warm antiseptic solution, after which it should be dried as well as possible and packed with warm gutta-percha. But in those cases where the gum tissue occupies the entire cavity, and especially where the tooth is aching, it should be removed at once. The electric cautery is doubtless the best means to use for disposing of this tissue. It is practically painless and no hemorrhage follows its use, which is an advantage. In the absence of this, other means may be employed. Hypertrophied gum tissue is quite tough and fibrous, and if it is elevated or pushed back by means of a flat instrument, it will usually be found that the attachment at the gingival margin is small and can easily be severed by employing gum scissors or a lancet, previously dipped in phenol. It is best not to tell the patient what you are going to do, for scarcely any pain will be experienced. The hemorrhage in these cases is usually profuse, but can readily be stopped by cauterization with 95 per cent. phenol or a 50 per cent. solution of phenolsulphonic acid. The blood should now be thoroughly removed, the cavity dried, moistened with eucalyptol, and packed with gutta-percha, letting it extend buccally and lingually to fill the interproximal space. The gutta-percha can be removed from the interior of the cavity with a heated flat instrument. Quite often the most practical way of adjusting the rubber dam in these cases is to place the clamp on the tooth posterior to the one thus packed, letting a single hole in the dam include both teeth. The packing, if properly placed, will prevent leakage. The pulp can now be removed by the method which the operator deems the most feasible. Conduction anesthesia may be used in these cases to great advantage. It prevents pain on the part of the patient and saves time for the operator in handling all such difficult cases.

It might be mentioned in this connection that hypertrophied gum tissue may and frequently does occur from irritants other than roughened cavity margins near the gingivæ. The condition results from chronic inflammation of the gums and from such mechanical irritants as salivary and serumal deposits, ill-fitting crowns, bridges and partial dentures. Certain constitutional conditions may also produce hypertrophy of the gums. Among these may be mentioned scurvy, mercurial poisoning and malnutrition, especially in children

and particularly among the poor in large cities. Marshall[1] classifies hypertrophy of the gums as a precancerous lesion and says, "Mechanical irritation is dangerous and should, therefore, be removed at once."

Importance of a Correct Diagnosis as to the Kind of Tissue in a Cavity.—There is one instance in the removal of pulps from teeth where students, particularly, are liable to make a serious mistake if they are not extremely careful. This is in cases where, in large occlusal cavities, especially in lower first molars of children, the pulp has died and the decay has extended through the bifurcation of the roots, leaving rough edges which continually irritate the tissue, causing it to proliferate and ultimately fill the cavity. To carelessly force the anesthetizing solution into such a cavity, where the pulp in the canals is gangrenous, would be the means of causing an acute alveolar abscess. The application of arsenic trioxid would mean the loss of at least one tooth, perhaps one or two on either side of the one to which the application is made, with a portion of the alveolar process.

Before applying either the anesthetizing or devitalizing agent, a correct diagnosis should be made; we should ascertain definitely the kind of tissue in the cavity. With a little experience this is usually a simple matter. The history of the case as related by the patient will often serve as a guide. Pulp tissue is generally more sensitive than gum tissue, and when slightly pricked with a sharp instrument bleeds more profusely. If the tissue proves to be hypertrophied gum tissue it can be disposed of in the usual manner, the puncture closed temporarily with cement or gutta-percha and the tooth treated as the condition necessitates (see Fig. 26). When this cannot be accomplished, and the tooth kept free from infection, it should be extracted, which is the correct practice in most of such cases.

Hypertrophied Pulp Tissue.—In cases where the tissue is hypertrophied pulp tissue, it will generally be found unusually resistant to both local anesthetic agents and arsenic trioxid, and it is frequently necessary to resort to interosseous or conduction anesthesia, or to the administration of such general anesthetics as nitrous oxid and oxygen, in order to painlessly remove the tissue.

Secondary Dentin, Pulp Nodules, and Pulp Calcification.—Quite frequently we find cases where it seems almost impossible to force the anesthetizing solution through the dentin and into the pulp, and when arsenic trioxid is applied it has little or no effect. In these cases we can suspect that the pulp has receded because of some slight but

[1] Pacific Dental Gazette, November, 1916.

continued external irritation, the space being filled in with secondary dentin, the tubuli of which are irregular and do not run at right angles to the base upon which they rest, as in the normal dentin. Occasionally cases will present where the entire canal has been obliterated (see Fig. 16 and, p. 349). This condition is more often found in elderly patients. As a result also of external irritation, pulp nodules and pulp calcification are sometimes encountered. In removing the pulp in these cases, often the most painless and best results are obtained only by a combination of both the anesthetization and devitalization methods; for the removal of these pulp nodules and calcified pulps is often a difficult procedure. After we have used the selected anesthetic and pressure or previously applied arsenic trioxid and anesthetized or devitalized a portion of the pulp, we may be able to reach the pulp nodule or nodules without producing pain. But frequently these calcific bodies are agglutinated, and close the mouth of the canal; especially is this condition found in the molar teeth. The pulp tissue immediately under the nodule is extremely sensitive. In such a case the anesthetizing solution could not be forced into the canal without first removing the obstruction, and arsenic trioxid, if applied, would have no effect. These are cases which require much perseverance and patience on the part of both patient and operator. The nodule can sometimes be loosened by gently working around it with an exploring or other suitable instrument. The author has met with success by taking a small round bur and drilling past the nodule, care being taken not to puncture the root, then with the engine running rapidly the nodule is tapped and dislodged. When the obstruction in the pulp chamber and canals is removed the remaining tissue can be anesthetized or devitalized in the usual manner. If the devitalization method is employed, the arsenical preparation can be placed over the mouth of the canal with safety; but it is never advisable or necessary to place the preparation down in the canal. In all such cases it is generally more satisfactory to inject local anesthetics by the conduction or interosseous methods, and thus anesthetize the pulps, or nitrous oxid and oxygen may be administered.

REMOVAL OF PULPS FROM DECIDUOUS TEETH

There is, perhaps, no dentist who has been in practice for any length of time but has been called upon to remove an exposed pulp from a deciduous tooth. With the so-called "horrors of the dental chair" magnified in the child's mind, as is too generally the

case, this is not often the most pleasant thing the dentist is called upon to do. The question resolves itself largely into the proper handling of the child. Any expedient may be employed to gain the confidence of the little patient, after which either anesthetization or devitalization may be used as is deemed best under the conditions. Generally the latter method is preferable; and it will be found that the pulps are peculiarly susceptible to the action of arsenic trioxid. The preparation should not be left in the tooth longer than from ten to sixteen hours and then only a small amount should be employed. When the pulp is thus poisoned, formocresol should be used to complete the devitalization. After the pulp is removed, all that is necessary to fill the root is to flood with chloroform and eucapercha compound, and fill the entire cavity with gutta-percha. The use of

FIG. 29.—This radiogram shows the resorption of the deciduous molar roots, due to the eruption of the permanent bicuspids. In this case the pulps of the deciduous molars were vital.

Dentinoid will be found most satisfactory for filling the canals, as it will be resorbed with the tooth root (see p. 480). It is supposed by some dentists that resorption of the roots does not take place when the pulp is destroyed. This supposition is wrong. The root may not be resorbed as readily as though the pulps were alive, but that resorption does take place has been clinically demonstrated in the author's practice. Hunt, of Indianapolis, was of the opinion that the process here involved is one of absorption rather than resorption, and that the loss of tooth-root is usually due to the advances of the permanent teeth (see Fig. 29).

ARSENICAL POISONING

It may be well to re-consider here the treatment of *local poisoning by arsenic trioxid.* However, when such treatment is necessary, it is due to carelessness on the part of the dentist or the patient, or both. It is never necessary to tell the patient what drug or remedy has been used in the treatment of teeth, many times it is advisable not to do

so; but whenever an agent as destructive as arsenic trioxid is sealed within a tooth, the patient should be thoroughly impressed with the importance of keeping an appointment, and of returning before the appointed time should any untoward symptoms develop. The patient should also be informed that the teeth thus treated might ache for a few hours, as they sometimes do, even when cocain is a constituent of the arsenical preparation; but that the aching will be of short duration. In case, however, the tooth or gum becomes sore, they should be instructed to return at once.

In those cases where the arsenical preparation is not hermetically sealed within the tooth and some of it gets on the gum tissue, remaining only long enough to cause devitalization, all that is necessary is to first wash the part with an antiseptic solution, and then mechanically pick off the dead or sloughed tissue with sterile pliers until bleeding is produced, if this is possible, after which the part should be *disinfected* and the tissue *stimulated*. To disinfect the part, any good disinfectant can be used. Nothing is better here than the official 3 per cent. solution of hydrogen dioxid. As a means of stimulating the cells, iodin compounds are useful. The official compound solution of iodin (5 per cent.) can be applied by first drying the part. After removing the dead tissue and disinfecting, the author prefers applying the euroform paste on cotton or gauze or Analgentum may be used without the carrying vehicle (cotton or gauze). A prescription should also be written for an antiseptic mouth-wash with which the patient should keep the mouth as clean as possible. The treatment can be repeated as often as the case necessitates; usually one or two treatments will suffice.

In those severe cases where the arsenic trioxid has penetrated to, and devitalized the process as well as the gum, the first treatment is surgical. After washing with an antiseptic solution, the affected process should be removed with a suitable bur in the engine. It may be necessary in extensive cases to extract the tooth, after which the treatment is practically the same as has been outlined above (see Fig. 27, p. 375). Sometimes there is pain following the surgical removal of the affected process. In this case the euroform paste is especially indicated; the orthoform controls the pain, the europhen disinfects and stimulates, and the liquid petroleum keeps the saliva, laden with bacteria, out of the wound. The use of Analgentum, following the initial treatment, will give excellent results. This ointment is sufficiently stiff to remain in place without cotton or gauze as the carrying medium. The case should be watched closely and the stimulating treatment kept up until the part has healed.

The tissue in the interproximal space will never be fully reproduced, and will always be a source of more or less annoyance.

It will be noted that in discussing the treatment of local arsenical poisoning, no mention has been made of dialysed iron. The practice of applying this agent to the affected part is both useless and wrong.

In conclusion, the author desires to emphasize, what was stated in the beginning, that it is the plain duty of every practitioner to save the pulps of teeth in all cases where it can be done with any reasonable degree of success; yet experience and observation will soon show the folly of attempting to save a pulp that is in a state of passive hyperemia or true inflammation, and will prove also that in these cases the safest practice is to remove the pulp and subsequently fill the canals, notwithstanding the difficulty often attending the performace of this operation. It behooves us, therefore, to study carefully the pathology of the dental pulp, that we may be able to diagnose the condition correctly and apply our therapeutics accordingly.

THE CHEMISTRY OF PULP DECOMPOSITION

GENERAL CONSIDERATIONS

The subject of pulp decomposition is one that has commanded the attention of many investigators in our profession, and at the present time the conclusions as to the chemistry of the process are by no means uniform. While this fact is to be regretted, it must be remembered here that there are many difficulties presenting themselves to the student who attempts to study this complicated process from the chemic viewpoint, either for the purpose of outlining a *rational* treatment for the correction of the gangrenous condition, or for the purpose of solving the knotty problems of the discoloration of tooth structure from this source. Until we comprehend more fully the nature of the chemic reactions taking place in the splitting up of the complex bodies of dead pulp tissue and have a more definite knowledge of the intermediate and end-products thus produced, the application of drugs and remedies for the correction of the gangrenous condition and for the restoration of the color of the tooth structure can never be placed upon a rational basis, but must be empirical, as it has been in the past. This is not in accordance with the tendency of the present time. There is a strenuous effort being made in both medicine and dentistry, to rid the professions of much of the empiricism of the past and to place the treatment of all diseased conditions upon a rational basis. With this end in view the author desires at this time to direct attention to the chemistry of pulp decomposition.

It is essential in studying the chemistry of this process to first ascertain the chemic constituents of the original pulp tissue. So far as chemists have been able to determine, practically all of the elements are present in the pulp tissue and its vascular supply that are found in any other animal tissue. These elements are arranged in different compounds which make up the pulp tissue, the proportion of which varies from other tissues, and this, no doubt, accounts for the histologic difference between this and many of the other tissues of the body. However, from a general chemic examination of the pulp tissue we find it analogous, or nearly so, to all other animal tissue. This suggests at once the necessity for the

student's familiarity with the general composition of animal tissue, which will now be considered.

Chemic Composition of Animal Tissue.—There are at the present time about eighty-three elements known to chemistry; but of this number less than seventeen unite, in varying proportions, to form the chemic basis of the animal body. In fact, six elements are about all with which we are concerned in the study of the decomposition of the pulp tissue.

These elements are carbon, C; hydrogen, H; oxygen, O; nitrogen, N; sulphur, S; and iron, Fe.

For convenience in study, the various substances found in animal tissue are divided into two general classes, the classification being based upon the presence or absence of the element *nitrogen*, and are accordingly called nitrogenous and nonnitrogenous substances.

Nitrogenous Substances.—We are taught by physiologists that nitrogenous organic bodies take the chief part in forming the solid tissues, and to an extent are also found in the fluids of the body. *Proteid*, or *albuminous*, substances are the principal nitrogenous compounds, and one or more enter as an essential part into the formation of all living tissue. The elements which constitute the proteid molecule are carbon, hydrogen, oxygen, nitrogen and a small amount of sulphur. Iron and phosphorus are known to exist in the molecule of some proteid bodies. While some chemists have attempted to construct a formula for the molecule, none has been accepted as correct, the opinions of investigators being so varied. To the casual observer it may seem strange that a molecule consisting largely, as it does, of carbon, hydrogen, oxygen, and nitrogen, should have these four simple elements so arranged as to baffle chemists in their effort to construct a rational formula. But this difficulty is readily explained by the fact that of all the elements none differ more widely from each other in their physical and chemic properties than these four. Carbon is a solid substance which exists in nature in three forms: Charcoal, graphite, and diamond, and can scarcely be fused or volatilized. Hydrogen, oxygen, and nitrogen are colorless gases which cannot be solidified by any known means and can be converted into liquids only with difficulty. The three gases also differ in their chemic activity. Hydrogen is combustible; oxygen will not burn, but will support combustion; while nitrogen is perfectly indifferent. Fortunately, too, for nature, in her effort to arrange these elements into a complex molecule, the valency of each differs. Hydrogen is univalent, oxygen bivalent, nitrogen trivalent, and carbon quadrivalent, generally considered. Carbon

atoms have also, to a higher degree than the atoms of any other element, the power of combining with each other by means of a portion of the affinity possessed by each atom, thereby increasing the possibilities of the formation of complex compounds. Thus many atoms of the same element occur in each molecule, which, together with the fact that one of the elements is that peculiar, undecided and indifferent element, nitrogen, aids materially in explaining the reason for the instability of the proteid molecule, or the ease with which under certain conditions it is decomposed.

In order that the reader may be able to follow a theory which the author will advance in a subsequent chapter on the discoloration problem, it is well to remember here that the relative amount of nitrogen compared with sulphur found in the proteid molecule is 15 per cent. of the former to 0.3 per cent. of the latter.

Nonnitrogenous Substances.—The non nitrogenous substances consist of *carbohydrates* and *fats*. Several classes of carbohydrates are known to exist, all of which are much less complex than the proteid group; and the arrangement of the atoms in the molecule is much better understood. The carbohydrate molecule is composed of three elements—carbon, hydrogen and oxygen. There are always six (or a multiple of six) atoms of carbon in the molecule, while the hydrogen and oxygen exist in the proportion to form water. These compounds readily undergo the process of fermentation.

Human fats are principally mixtures of palmitin, $C_3H_5(C_{16}H_{31}O)_3O_3$; stearin, $C_3H_5(C_{18}H_{35}O)_3O_3$; and a small amount of olein, $C_3H_5(C_{18}H_{33}O)_3O_3$. As shown by the formula of these compounds, the molecules of each also consist of carbon, hydrogen and oxygen. The proportion of these elements varies in the different compounds. That fats are decomposed or saponified by alkalies, or ferments in an alkaline medium, should be remembered, both in the treatment and the bleaching of teeth.

Thus we have every reason for believing that the pulp tissue, like nearly all living organic tissue, is composed of *proteids*, *carbohydrates*, and *fats;* and on this hypothesis the author will endeavor to ascertain the intermediate and end-products resulting from the decomposition of this tissue when death occurs. Before doing so, however, it may be well that the reader fully understands what is meant by the terms *fermentation* and *putrefaction*. These terms are applied to peculiar kinds of decomposition by which the molecules of certain organic substances are broken up into simpler compounds. The difference between the terms is that fermentation is applied to the decomposition of those substances which belong to the group of carbohy-

drates, while putrefaction is applied to the decomposition of those substances which properly belong to the proteid group and are classified as nitrogenous substances.

Pulp Decomposition.—The decomposition of the pulp tissue is essentially an analytic process which takes place gradually. Conditions being favorable, the germs present first act upon the complex and unstable substances composing the original tissue, splitting them up into less complex compounds, many of which are capable of further analysis; and the process goes on until simple and well-known compounds are the result. For convenience in studying this subject the compounds resulting from this analytic process will be arbitrarily divided into two classes, *intermediate* and *end-products;* and it will be seen that it is largely the products of putrefaction rather than of fermentation with which we have to contend in the correction of the gangrenous condition.

Intermediate Products.—The intermediate products depend to an extent upon the character of the microorganisms in the tissue, but it is safe to say that certain *ptomains* and *amido-acids* are formed.

1. **Ptomains.**—Ptomains are nitrogenous compounds of organic origin, having the reaction and basic property of alkalies. By some authorities they are called *animal alkaloids*, to distinguish them from a similar group of organic bases known as *vegetable alkaloids*.

Among the ptomains liable to be produced are putrescin, $C_2H_{12}N_2$, cadaverin and neuridin, $C_5H_{14}N_2$, the last two named being isomeric as shown by the formula. One of these ptomains, neuridin, is nonpoisonous; therefore its presence is of little importance other than to know that it is a nitrogenous base from which ammonia, NH_3, or derivations of ammonia, is evolved by further putrefaction. Still, according to Vaughan and Novy, while pure neuridin is nonpoisonous, it possesses a toxic property as long as it is contaminated with other poisonous products of putrefaction. This holds true for all nonpoisonous bases. In so far as the correction of the gangrenous condition is concerned, putrescin and cadaverin are perhaps the most important intermediate products known to be formed in the splitting up of the proteid molecule. Like neuridin, they are basic nitrogenous compounds, capable of undergoing further putrefaction, evolving ammonia or derivatives; but unlike this compound, while they were at first regarded as physiologically inactive, both of these bases have been proved by Scheurlen, Grawitz and others to be capable of producing inflammation and suppuration. Therefore, if by instrumentation or otherwise they are forced through the apices of the roots, septic pericementitis or perhaps an acute alveolar abscess will result.

2. Amido-acids.—Amido-acids are acids in which hydrogen has been replaced by the univalent radical, NH_2. Among the amido-acids formed in pulp decomposition, in all probability, are tyrosin, $C_6H_4OHC_2H_3(NH_2)CO_2H$, and leucin, $C_5H_{10}NH_2CO_2H$. These substances, wherever found have practically the same physiologic properties and pathologic significance. They occur in the intestine during the digestion of proteids, and leucin is found in almost every cell of the animal body.[1] Pathologically, they are found in atheromatous cysts, in pus, abscesses, etc., as well as in a gangrenous root canal. It is well to remember here that these intermediate products are also nitrogenous compounds from which ammonia, or derivatives of ammonia, is evolved by further putrefaction, and that *fats are one of the end-products.*

End-products.—The chief end-products of pulp decomposition, as has been known for a long time, are water, H_2O; carbon dioxid, CO_2; acetic acid, $HC_2H_3O_2$; ammonia, NH_3; hydrogen sulphid, H_2S; and a semi-putrid substance consisting largely of fats, depending upon the extent to which the putrefactive process has progressed.

Simultaneously with the decomposition of the pulp tissue proper, the dentinal fibrillæ are broken up, as is also the hemoglobin and other constituents of the blood; and the tubuli as well as the pulp chamber and root canals are filled with the intermediate and end-products of the decomposition.

The principal gases generated by the putrefaction of the proteid substances, the main constituent of the original pulp tissue, are *ammonia* and *hydrogen sulphid.* Now, it is interesting and important to know which of these two gases is evolved in the greater quantity. This is easily estimated when we recall the relative amount of nitrogen and sulphur found in the proteid molecule. As previously stated, there is approximately 15 per cent. of the nitrogen to 0.3 per cent. of sulphur. Hence, ammonia is evolved in the greater quantity. It is quite evident, then, that hydrogen sulphid is not generated in a gangrenous root canal in such quantities as has been so generally supposed; yet this compound is a constant end-product and is important, because it is an *acid* gas, with a disagreeable odor, having local irritating properties; and also because of the part it plays in the discoloration of the tooth structure. The author desires to state here, however, that while he realizes hydrogen sulphid is an active chemic agent, in his opinion it has been greatly overestimated in the role it assumes in the discoloration of teeth from pulp decomposition as will be shown later.

[1] Simon's "Manual of Chemistry."

In our study thus far of the chemistry of the complicated process of pulp decomposition, we have learned something of the nature of the intermediate and end-products resulting therefrom, and now it is possible for us to select, with some intelligence, drugs and remedies which will not only destroy bacteria, but will also act chemically upon these noxious products, converting them into noninfectious and nontoxic compounds.

DIAGNOSIS AND TREATMENT OF PULPLESS TEETH AND THEIR SEQUELÆ; INCLUDING THE PREPARATION OF THE CANALS FOR FILLING

GENERAL CONSIDERATIONS

Before discussing the therapeutics of the subject under consideration here, it is well to direct attention to the careless and erroneous use of certain terms by some physicians and dentists in relation to a tooth without a pulp. In describing such a tooth the terms "dead," "devital" and "nonvital" have been used. These terms all mean *without vitality* or *life*, and should not be applied to a tooth without a pulp; for it gives an erroneous impression. A dead tooth in the jaw would not be tolerated by Nature, and would soon be exfoliated. What is meant here is a "pulpless" tooth, and this is the term which should always be used.

As has been elsewhere stated the dental pulp is the formative organ of the dentin; and in a sense is a transitory structure. If one lives to extreme old age it disappears, secondary dentin filling the space it formerly occupied; but the tooth still lives since the cementum receives its nutrition wholly from the pericementum and not from the pulp. Marshall has shown that the dentin and cementum are distinct structures without communicating fibres—the one (dentin), receiving its nourishment from the pulp, the other (cementum) from the pericementum. The death of the pulp affords opportunity for periapical infection; but if the root-canal of a pulpless tooth is made aseptic and is properly filled, the root does not usually become infected subsequently and so-called dental granuloma or alveolar abscess does not result.

It should be noted here that the "growth" which is frequently found around the apex of a pulpless tooth which is harboring or is infested with bacteria is not a *granuloma* in the true sense of the term. It is a defensive membrane built up by Nature to wall off the infection and Pollia more properly calls this a *periodontoma*. When the term granuloma, therefore, appears in the text of this book, this is what is meant.

To know a tissue or organ in disease one must first know it in health. It is, therefore, essential that the student and practitioner

be familiar with the normal structures found in the periapical region of teeth; and to know also the pathologic changes which these structures are capable of undergoing when irritated and inflammation ensues. Fig. 30 shows the normal cancellated bone about the roots of teeth—the outer or compact layer having been removed. When the periapical tissue is involved in an infection this cancellated bone is nearly always involved in the inflammatory reaction. Generally there is either an acute or chronic osteomyelitis, involving, as the term implies, both the calcified, osseous tissue and the medullary or

FIG. 30.—This shows the normal cancellated bone about the roots of teeth—the outer compact layer of bone having been removed.

myelitic substance. The result is either rarefaction or condensation of bone, or both. Federspiel speaks of the latter condition as bone sclerosis. (See Figs. 31 and 32.) We rarely have a simple case of gangrenous pulp, especially if it has stood for any appreciable length of time, without having more or less involvement of the periapical structures; and when such a case does present, an effort should be made to correct the gangrenous condition in the canal and disinfect the tooth structure with the least possible injury to the tissue beyond. Hatton is lead to believe from his work that a pulpless tooth infested with or harboring bacteria always produces an involvement of the osseous structures, the infection following the lymph channels directly into the cancellous bone. This he claims is both an advantage and a disadvantage so far as treating a pulpless tooth is concerned. The advantage comes from the fact that the pericementum is not stripped from the cementum, as was formerly thought to be

the case, and the disadvantage in that the bone is immediately involved. Puterbaugh states that bone is the least resistant to infection of any tissue of the body.

FIG. 31.—This case is from the practice of Dr. J. M. Thompson of Detroit. Patient presented with an abscess. The canal was opened and cleansed and formocresol sealed in, with instruction for the patient to return in a few days. It was about a year when the lady returned. Tooth gave a favorable history, dressing dry and canal was filled at once. Arrow points to bone condensation or bone sclerosis.

The treatment of pulpless teeth with gangrenous pulps and their sequelæ has in the past, to a great extent, been purely empirical. The reason for this can be found in the apparent lack of interest which generally has been shown in the chemistry of pulp decomposition.

FIG. 32.—Note disappearance of bone sclerosis and bone regeneration with formocresol dressing in canal during entire period (about a year).

A knowledge of the changes wrought in the splitting up of the complex bodies of the dental pulp by microorganisms is of vital interest to every practising dentist; and every student should, therefore, familiarize himself with this important subject. The only method by

which drugs and remedies can be scientifically applied to the treatment of the condition under consideration is to have a definite knowledge of the intermediate and end-products resulting from the putrefactive process. For this significant reason the Chemistry of Pulp Decomposition, as understood by the author and presented to the profession many years ago, has been included in this work.

Every practitioner of dentistry knows from sad past experience that in the process of pulp decomposition some kinds of mephitic gases are evolved which, if confined, would produce severe pathologic disturbances; but just what the gases were and how the unfavorable conditions were brought about we were left to conjecture. From our study of the chemistry of pulp decomposition we have every reason for believing that the main gases produced are *ammonia* and *hydrogen sulphid*. When these gases are generated and cannot readily escape through a cavity, pressure is produced, thereby forcing the infectious material through the apices of the roots into the surrounding tissues from which infection, septic pericementitis and, in many instances, an alveolar abscess result.

Coagulating Drugs.—There has been much discussion in the dental literature of the past in regard to the penetrating or non-penetrating power of coagulating agents in gangrenous root-canals. It is true, as claimed by some authorities, that such drugs as phenol, creosote, solutions of zinc chlorid, etc., are contraindicated in the treatment of gangrenous pulps, but not because they possess the coagulating property; for when the dental pulp is undergoing or has undergone the process of decomposition, the proteid constituents, or coagulable substances, have lost their former identity, and new compounds, with entirely different properties, have been formed. In selecting drugs to be used in the treatment of this condition, the author will therefore eliminate the question of coagulation, and will select drugs which, if properly used, will unite chemically with the intermediate and end-products of pulp decomposition, converting them into odorless and noninfectious compounds, as well as destroy germ life.

Important Products of Pulp Decomposition.—In this connection it should be remembered that the gangrenous condition has been brought about through the agency of microorganisms by a gradual analytic process, and among the products formed which must be considered in the treatment are *hydrogen sulphid*, *poisonous ptomains* or *toxins*, and *ammonia* or derivatives, the latter gas being evolved from the further putrefaction of the intermediate compounds (ptomains and amido-acids). It is well to remember also that *fats* or fatty acids

are a class of end-products resulting from the putrefaction of proteid substances.

The main gases formed, then, are ammonia and hydrogen sulphid. Now it will be necessary to dispose of these gases by our initial treatment in order to hermetically seal the cavity, an object the accomplishment of which is much desired in the treatment of these cases; for by so doing we prevent the oral fluids from contaminating the medicine within the tooth, the medicine from escaping into the patient's mouth, and the tooth from changing color during the time of treatment.

Drugs Indicated.—It has been shown by Cassidy and others that *formaldehyd* (CH_2O) is a valuable therapeutic agent if properly used. This gas occurs in commerce in a 37 per cent. aqueous solution, which solution is recognized by the United States Pharmacopeia under the name of liquor formaldehyd, or formalin. The gas will unite with ammonia, producing urotropin, a solid, as $6CH_2O + 4NH_3 = (CH_2)_6N_4 + 6H_2O$.

Formaldehyd unites also with hydrogen sulphid, forming, in the author's opinion, methyl alcohol, a liquid, and sulphur, a solid, as $2CH_2O + 2H_2S = 2CH_3OH + S_2$.

It is stated on good authority that this same gas, formaldehyd, unites with basic ptomains, forming inodorous compounds. By the use of formaldehyd, then, in our initial treatment for a gangrenous pulp, the *irritating gases* and *poisonous liquids* (largely ptomains) can be changed chemically into *nonirritating* and *nonpoisonous liquids* and *solids*. The official solution of formaldehyd, however, is too irritating for general use; therefore, inasmuch as fats result from pulp decomposition and are present as such in a gangrenous root-canal, the author, several years ago, selected *cresol* as an agent with which to dilute the official solution and thereby modify the irritating action of formaldehyd. Cresol is also recognized by the United States Pharmacopeia under this name. Formerly the product was commercially called *tricresol*. This agent has a tendency to darken when exposed to light. It is recommended that a clear solution be obtained and then kept in an amber-colored bottle.

Liquor formaldehyd can be diluted with such other agents as phenol, or creosote, if, in the latter instance, a small amount of alcohol is added to clear the solution. Cresol, however, is recommended for four principal reasons:

1. It is miscible with the liquor formaldehyd in all proportions, thus making, without the addition of alcohol, a good pharmacal product from which formaldehyd gas is constantly generated.

2. It is a good disinfectant—much more powerful than phenol.

3. It possesses an anodyne property which modifies the irritating action of formaldehyd.

4. It acts chemically upon fatty compounds, thereby disposing to advantage of these substances.

Factors to be Considered.—In the successful treatment of the conditions under consideration, there are three important purposes to be accomplished:

1. Establish asepsis.

2. Prevent recurring sepsis.

3. Preserve or restore the color of the tooth.

In calling the attention of the reader to a method of treating this condition, which has proved very successful in the author's practice, I desire to emphasize the necessity of observing the details of the method. The successful management of pulpless teeth is largely a matter of chemistry, and the treatment involves the use of certain chemic agents. In view of our present knowledge of focal infection and its relation to systemic disease, the author considers the treatment of pulpless teeth one of the most important subjects before our profession to-day.

Diagnosis of Dead Pulps.—It is not a difficult matter, as a rule, to differentiate between teeth containing living or dead pulps. The clinical history, the color of the tooth, its response or nonresponse to thermal or electrical stimuli, will lead us to suspect that the pulp is dead or alive. Now we are ready to confirm our diagnosis. One of the best means of confirming the diagnosis of a dead pulp is the use of electricity by an instrument known as the "vibrating coil." This consists of a single dry cell and a vibrating coil with a switch to control the current. The cord leading from the positive pole is arranged with a holder so that a broach may be attached; cotton is wrapped around the broach and moistened when it is applied to the suspected tooth. The cord from the negative pole is attached to a metal holder, which is held by the hand of the patient; thus the circuit is completed. A stronger current may be had by moving the positive pole to the right on the instrument or by gradually withdrawing the cylinder which runs through the coil. One should always start with a weak current, gradually increasing the strength if no response is obtained. It is best to apply the current first to a tooth known to be vital, and use this as a control or guide. When two approximating teeth contain metal fillings, the current should be applied to the tooth so as not to come in contact with the filling; otherwise the current may be conducted to

the filling of the adjoining tooth, which, if vital, would respond, leading one to believe that the tooth to which the current is applied is vital, when, as a matter of fact, it may be pulpless. The new unit outfits on the market have a pulp vitality tester as a part of the equipment.

In the diagnosis of these conditions the radiogram is a valuable aid *but by no means positive.* Many times teeth contain dead pulps without periapical involvement, at least sufficient to show in the picture. Then, again, care must be taken in reading the radiogram to eliminate possible radiolucent areas which are not pathologic.

After the diagnosis of a dead pulp has been confirmed, the pulp chamber is freely opened with a suitable round bur. It is not enough here to simply determine whether the pulp is dead or alive; but, if dead, an effort should be made to determine whether the condition is one of true gangrene with its characteristic odoriferous and gaseous end-products or whether, as sometimes occurs, the active pyogenic microorganisms have liquefied a part or all of the bulbous portion of the pulp, forming drops of pus in the pulp chamber with practically no odor, and with the tissue in the canals still vital.

Treatment of Pulpless Teeth.—When a patient presents with a pulpless tooth, the original pulp tissue is generally either in a moist gangrenous condition, as a result of the action of bacteria (Fig. 33) or a previous attempt has been made to remove the pulp and fill the canals. (See History of Cases, p. 416.) In either case, the first treatment here, in my opinion, should be a dressing of *formocresol.*

℞—Cresolis,
Liquoris formaldehydi, āā f℥j (4.0 cc.).—M.
Sig.—Use as directed.

Other preparations may be just as effective; but this is the one I have used for years and about which I can speak with assurance. Under aseptic precautions, this remedy should be placed in the pulp chamber only, and the dressing retained with cement. This dressing should remain at least twenty-four hours.

The chemic action of formocresol on a gangrenous pulp has been previously mentioned and need not be repeated here. I know that many good men to-day advocate the immediate cleansing of a gangrenous canal; but I am firmly of the belief that the safest and best practice is to first supply at least one dressing of formocresol. Gilmer, Moody, and others, have found that the predominating organism in the conditions resulting from a gangrenous pulp, therefore the group active in bringing about the decomposition,

is a streptococcus, "with graded variations from a hemolytic streptococcus with a wide zone of hemolysis in the acute abscess to a *streptococcus viridans* in the chronic." One initial treatment of formocresol in these cases, while it may not kill all of the organisms present, will certainly lessen the number and lower the virulency of those remaining. This is brought about by limiting the number and reducing the bacterial colonies present. It is well to remember in this relation that wounds heal and bone regenerates under conditions which Carrel calls "surgical sterility." A limited number of germs in a part generally provokes a fight in which Nature is victorious. Surely no one will deny the favorable and valuable effect of formaldehyd gas on the intermediate and end-products of pulp decomposition. With these poisonous and irritating products chemically neutralized; with the bacteria, inaugurating the process, killed or their virulency lowered, we may the more safely, I believe, work to the root-end, and clean and enlarge the canal by a *chemico-mechanical* process. By this I mean the use of chemicals in connection with broaches, reamers, files, and other necessary instruments.

At the present time, so far as I know, there are three chemic agents in general use for this purpose—*metallic potassium* and *sodium*, as advocated by Rhein; *sulphuric acid* by Callahan; and *phenolsulphonic acid* by the author. We will now consider the chemistry and pharmacology of these agents.

Potassium and Sodium (K and Na).—This is an alloy composed of a mixture of the two metals. It occurs as a semi-solid, silvery-white preparation. Like the metals of which it is composed, it must be kept under a hydrocarbon oil or paraffin to protect it from the air and moisture. It was first introduced in the United States by Schreier, of Vienna, in 1893, at the World's Columbian Dental Congress in Chicago. So far as I am able to learn, Schreier has never published the proportion of the metals in his product. The metals will produce an alloy in varying proportions; and, in my opinion, the more sodium in the mixture the better the preparation will be as long as there is enough potassium to make an alloy when the two metals are properly mixed. No attempt should ever be made to mix the metals unless they are constantly kept under a hydrocarbon oil, such as kerosene, gasoline or benzene; and, even then, it is best to leave the compounding to an experienced chemist or pharmacist.

Technic of Using Schreier's Alloy.—Schreier's preparation comes in a small glass tube, one end of which is open so that the alloy may be covered with paraffin, which prevents undue exposure to air or moisture. It is to the advocacy of Rhein that the preparation owes

its popularity in this country. He has developed a technic which, if followed carefully, insures success. With the rubber dam adjusted and everything in readiness, a barbed broach may be pushed through the paraffin cover and into the metallic mass; on gently withdrawing it small particles adhere to the broach. It is best to have these particles as near the end of the broach as possible, in which manner the alloy is transferred to the canal. It is presumed that the canal is moist, which is generally the case. A violent reaction at once takes place, the metals attack the water molecule and hydroxids are formed, liberating hydrogen gas. If potassium predominates in the alloy, or even if it is present in equal proportion with the sodium, a sufficient amount of heat is generated by the reaction to cause the liberated hydrogen to burn. To set the hydrogen off actively and start it burning requires a temperature of from 500° to 600°C. This burning of the hydrogen is an objection, in my opinion, and it was for this reason that I suggested (above) the employment of an alloy with sodium predominating. After the initial reaction and the hydroxids are formed, they in turn act upon the fatty end-products, in case of a gangrenous pulp, forming a soluble soap. Where the organic tissue has not been decomposed by bacteria the action of the hydroxids differs somewhat in that the hydroxyl ion unites with the protein constituent of the tissue, forming a soluble alkaline albuminate. In either case, it will be observed, the product formed is *soluble*, and may be washed out of the canal, leaving it clean and sterile.

The action of potassium and sodium hydroxid on the contents of a canal of a tooth, whether or not the tissue is decomposed, is the same. When the salts and compounds of these metals are internally administered their action differs only in that the potassium ion is more depressant than the sodium ion in its influence upon the cardiac, muscular and nervous systems. But in the canal of a tooth we do not have this pharmacologic effect of the metal ion; here we get only that which is desired—the chemic action of the hydroxyl ion.

Rationale of Rhein's Method.—With this information before us, let us examine the rationale of Rhein's method of using metallic potassium and sodium in the treatment and preparation of canals for filling. The chemistry is correct; a description of the method reads well. The question is whether the preparation is safe and practical. My reply is that it is safe in the hands of those who will master the technic and use it with intelligence and care; but that it is not as practical as other chemicals which may be used with equally good results. It must be remembered that each particle of alloy that is introduced into a canal is decomposed just as soon as it

comes in contact with moisture. This practically means that the initial reaction between the metals and water takes place at the mouth of the canal; for it is difficult to keep the canal free from moisture down to the place at which we stop each succeeding time we enter it with the broach or other instrument. The mere withdrawal of the latter would necessarily moisten the canal, more or less, which had been affected by the remedy. Then, too, if we are using an alloy, like Schreier's, in which there is enough potassium to cause the liberated hydrogen to burn, as a result of the intense heat from the violent reaction between the metals and water, *we are constantly moistening the canal;* for when hydrogen burns it does so by virtue of the oxygen in the air supporting the combustion, and water (H_2O) is chemically formed. Therefore, it is impossible to keep the canal free from moisture when we use an alloy which reacts on water with such violence that the heat generated causes the hydrogen to burn. Even Rhein himself, with all his experience, technic and care, wisely cautions against the possibility of destroying, or affecting deleteriously, the tooth structure at the mouth of the canal by this "burning" process. Does this not mean, then, that unless extreme care is taken to prevent the initial reaction until the alloy is down in the canal to the point desired, the chemicals which actually do the work down in the canal proper are the hydroxids of the metals? If this be true, why should we not introduce into the canal and use one of these hydroxids (there is absolutely no advantage in using both) from the beginning? When I want the action of these alkalies in a canal, I generally use, after the method of Pruyn, of Chicago, a saturated solution of sodium hydroxid (NaOH). This is a rather thick, syrupy solution, which may be applied like any solution of its kind.

There is another objection to the use of metallic potassium and sodium, especially a mixture of the metals in which potassium predominates or is present in equal proportion. Granting that with proper care one could keep moisture from the canal as he gradually approached the end in the use of the alloy, I am one of those who firmly believe that we should not *burn* our way through the live, healthy cementum at the end of the root from which a live pulp has been removed. One of the first things a student learns in studying chemistry is "that hydrogen burns with the hottest known flame." With a dental granuloma or alveolar abscess in the periapical region, it is a different proposition; but, even here, we may accomplish our purpose with far less destructive chemicals.

This brings us to a discussion of the use of "acids" instead of "alkalies" for the purpose under consideration. The acids which I shall discuss are sulphuric acid (30 per cent.) and phenolsulphonic acid (80 per cent.).

Advantages of Phenolsulphonic Acid.—The chemic action of sulphuric and phenolsulphonic acids for the use under consideration is practically the same; and they will be discussed here conjointly. Personally, I prefer phenolsulphonic acid. Its consistency is thick and syrupy in the 80 per cent. strength which is recommended; thus a drop will adhere to the end of a broach or other applicator, permitting it to be carried even into the canals of upper teeth without difficulty. The acid does not materially affect a broach, and if any of it accidentally gets on the enamel of the crown of the tooth and is not noticed for a time, it does not decalcify and whiten the spot to the extent that sulphuric acid would do. When the acid is worked through the end of the root, as is desirable for cauterization in cases of a dental granuloma or alveolar abscess, it is sufficiently cauterant for the purposes desired, yet not as destructive as sulphuric acid would be; and, owing to its analgesic tendencies, causes less pericementitis. In this connection, however, I want to say that we should not expect to do this work as it must be done, without more or less soreness following the treatment. There is a wide variance in patients regarding the reaction of the periapical tissues to these agents; and in these chronic conditions it is generally best to invite and create inflammatory reaction that the sluggish cells in the area may take on new life and activity. This should not be done, however, at the expense of unnecessary destruction of tissue.

It might be supposed by those who have not used phenolsulphonic acid that, possessing the above-mentioned advantages over plain sulphuric acid, it would be less effective in the canal. I have not found this to be the case. The agent has one possible disadvantage. In using either of these acids, after they have been introduced into the canal for a time and the walls thereof filed or scraped with a suitable broach, they should be neutralized with a solution of sodium bicarbonate ($NaHCO_3$). In the case of sulphuric acid the salt formed as a result of the reaction is sodium sulphate (Na_2SO_4), a freely soluble salt. With phenolsulphonic acid the salt formed is sodium phenolsulphonate ($NaSO_3.C_6H_4.OH + 2H_2O$), which is not as soluble as sodium sulphate. I can conceive how it might be possible in a very fine canal to temporarily block it with the salt formed. An excess of water would readily dissolve the salt or by

using a solution of sodium bicarbonate of not more than 10 per cent. strength the salt would be dissolved as soon as formed by the reaction. This is a thing which probably would never occur in practice; but I mention it as a possible disadvantage.

Caution in Using Callahan's Method.—In using sulphuric acid Callahan advises that it be a 30 per cent. solution. In this strength there is not the danger of charring or carbonizing the pulp tissue which may be in the canal undecomposed, that there would be if a more concentrated solution were used. Sulphuric acid is one of the most corrosive acids. When applied to the skin, accidently or otherwise, in concentrated form, it causes an intense, burning pain, and results in a rapid destruction of tissue. The eschar is at first white, gradually becoming brown, and causes a coal-black slough. The corrosive effect upon mucous membranes or the tissue in the periapical area of teeth is still more marked than upon the skin. The acid rapidly abstracts water from the tissue, the alkalies are neutralized and the proteins precipitated, which results in complete destruction of the tissue. This carbonizing of the undecomposed tissue in the canal should be avoided, as it forms a mechanical obstruction difficult to remove; and it is for this reason that the 30 per cent. solution is recommended by Callahan.

It may be mentioned here that some practitioners prefer to use hydrochloric acid for cleansing the canal, because of the fact that the salt formed as a result of the acid acting on the tooth structure is soluble and more readily removed. This slight advantage is far outweighed by other more important considerations mentioned in connection with phenolsulphonic acid.

Technic of Using Acid Method.—We will now consider the technic of treating pulpless teeth and preparing the canals for filling by the "acid method." I take it to be thoroughly understood that good root-canal work means the use of the rubber dam in all cases, and the strict observance of asepsis. With me at this time, as heretofore, it means asepsis fortified by antiseptic precautions. I make this statement because it is so difficult to observe strict asepsis in our dental offices.

In a large percentage of cases of gangrenous pulps or imperfectly filled canals, the radiogram will disclose a dark and suspicious area at the end of the root. With this evidence, and under the conditions, we may properly diagnose the case as a *dental granuloma* or *alveolar abscess*. This growth may be nonpurulent or of the pus-discharging variety. It is only recently that these nonpurulent growths—so-called granulomas, true periodontomas—have been

recognized as such; and the treatment of such conditions in the past has not been as specifically emphasized as their significance merits. In this relation it should be noted that Endelman, Price and others have directed attention to the fact that the term "granuloma" here is a misnomer. In his recent work[1] Price states that this so-called granuloma is a defensive membrane and not a neoplasm. Continuing this author says, "A normal functioning periapical quarantine tissue is Nature's effective mechanism for protecting that individual by destroying the organisms and toxins immediately at their source, thereby completely preventing the tissues of that individual's body from exposure to either of these agencies."

Nonpurulent Variety.—It makes no difference with me whether this growth is associated with a tooth, the canal of which contains a gangrenous pulp, *per se*, or an imperfect root-canal filling—the treatment is practically the same. At the first sitting, when the diagnosis is made by the aid of a radiogram, or even before the latter is obtained, under aseptic precautions, the pulp chamber is opened into freely and a dressing of formocresol is hermetically sealed in for two or three days. Cement should always be used here to retain the dressing. This treatment is for the purpose of neutralizing the gangrenous contents of the canal, or, in a measure, sterilizing the old root filling, as the case may be. In making an attempt to work one's way by chemico-mechanical means to and through the root-end without the previous application of some strong disinfectant, like formocresol, I have found that acute symptoms too frequently develop. This initial formocresol treatment prevents many of the acute symptoms which follow the immediate attempt to reach the root-end, however careful one may be. At the second sitting, I want the radiogram; then with the rubber dam always in place and all necessary instruments sterilized, I carefully work to the apex with phenolsulphonic acid, using in connection therewith fine, smooth, twist and file broaches. This is what I call the chemico-mechanical process. The acid is frequently neutralized with a solution of sodium bicarbonate; and since phenolsulphonic acid is the chemical I am using, for reasons previously mentioned I prefer not to have the alkaline solution more than 10 per cent. in strength. If sulphuric or hydrochloric acid is the agent used, this point is not so essential. The sodium bicarbonate solution not only chemically neutralizes the acid, but the effervescence caused by the reaction aids materially in removing the "mushy" and disintegrated material from the canal. After I am satisfied that I am at the end of the root, that the acid is

[1] Dental Infections, Oral and Systemic, Vol. I, p. 469.

neutralized and the canal perfectly clean and sufficiently enlarged, then, if the radiogram has indicated a periapical involvement, with the acid and a small stiff broach, I work my way through into the affected area. Some of the acid is purposely worked through the end for the express purpose of destroying the growth. In the first edition of this book (1909), I spoke of phenolsulphonic acid as a stimulating cauterant and called it a "bone cell stimulant;" and after several years of further use of the agent in these conditions, I am still of this opinion. Personally, I have obtained better results by using phenolsulphonic acid than any other agent at my command. The acid destroys or breaks down the defensive membrane, encouraging and favoring bone regeneration after the root is filled. When I am through the root-end, the acid in the canal—not that which has passed through—is neutralized with the sodium bicarbonate solution, the canal desiccated with *modified alcohol* (70 per cent. alcohol to which 1 gr. of thymol is added to the fluid ounce), and a dressing of eucalyptol compound (very little of the remedy on the cotton) is sealed in the canal. This remedy is used here because it is a stimulating antiseptic, thus fortifying asepsis with antiseptics; but, as elsewhere mentioned, it also aids in hermetically sealing the canal which is done at this time by using a combination of a good grade of temporary stopping and cement. The heated stopping is placed immediately over the eucalyptol compound dressing and it adheres firmly to the walls of the cavity; the excess is removed and the remaining portion of the cavity filled with cement. This dressing is left for a period of from four days to a week, when, if the case has progressed nicely and pericementitis is absent, the canals are filled.

What becomes of the growth and tissues that were cauterized in the periapical region, I frankly admit I do not know; neither does anyone else. Nature here, as in many other instances, has not revealed her secret; but I do know that it is disposed of in some way, for under the above treatment bone and soft tissue regeneration is effected (see History of Cases with Illustrations, p. 416). When, in all therapeutics, we learn to work *with* and not *against* Nature, we will have taken a long step forward. If, in these cases, the root-end can be put and kept in such condition that the surrounding tissues can lie in physiologic contact with it, regeneration is effected; if this biologic condition cannot be brought about, all medication fails and surgery is the only road to success.

It is well to remember in this relation that Hatton and Puterbaugh have repeatedly directed attention in recent years to the fact

that the pericementum is not detached from the cementum in recently involved cases. In an examination of a large number of such cases in the dissecting room, Puterbaugh found that only a small area of membrane immediately around the apex was destroyed, and this was not always the case. Hatton explains how the infection follows the lymph channels directly and immediately into the cancellous bone and does not denude the root-end of its pericementum. These are hopeful and encouraging findings for the dental therapeutist.

Removing Old Root-filling.—In those cases where a previous attempt had been made to fill the canal with gutta-percha, it is necessary, after the initial formocresol treatment, to first remove the old root-filling. Generally in these cases there is only one cone in each canal, in which event the acid will soon work its way around the cone when it may be loosened with a suitable instrument and removed in one piece. However, occasionally it becomes necessary to remove a filling where the gutta-percha has been firmly packed in the canal. Here the use of xylol, or xylene, as it is also called, will aid materially in disintegrating the gutta-percha. This is dimethylbenzene ($C_6H_4(CH_3)_2$), and while the agent does not dissolve the gutta-percha in the sense that chloroform would, it readily attacks and disintegrates the material, making its removal, after a few minutes, comparatively easy. After the canal is open, chloroform may be used on cotton to thoroughly soften and remove all the gutta percha, for a little left might form a blockade. My attention was called to the use of xylol by Best, of Minneapolis; but I think he credits another with its introduction. It may be procured from any pharmacy.

Removing Blockade in Canal.—We should never use any drug or chemical blindly. Therefore, if in working up or down a canal, we find it blocked and are unable to reach the end, instead of going on blindly using only one chemical, whatever it may be, and running the risk of making a false pocket, we should stop and ascertain, if possible, and it is generally possible, the nature and character of the material causing the blockade. It may be a remnant of an old gutta-percha cone; it may be pulp tissue undecomposed which has been inadvertently packed in the canal; it may be some inorganic material, such as a pulp nodule, secondary dentin, or other loosened inorganic material which has been pushed into the canal. If we have reasons for concluding that an old gutta-percha filling is causing the blockade, xylol is the chemical to use; if we think it is organic tissue, the alkalies, like potassium and sodium or a strong solution of

one of the hydroxids of these metals, is indicated; if an inorganic material, sulphuric, hydrochloric or phenolsulphonic acid will best answer our purpose. My plea is not to become wedded to any one chemical or method. Be eclectic and take the necessary time to do this work carefully and well. It is the most important work you have to do.

Purulent Variety.—The treatment of an alveolar abscess of the purulent or discharging variety is practically the same as previously outlined, except that in these cases there is not the danger of acute symptoms arising; therefore, one may safely, under aseptic precautions, work to and through the root-ends without the initial formocresol treatment. However, even here I believe it is the best practice to use formocresol first; but it is not so essential as in the case of non-purulent growths. After we are through the end of the root, it is best to first force a physiologic salt solution through the sinus, and if no sinus is present it is generally best to establish an opening through the overlying soft tissue and process, then cauterize the track with some stimulating cauterant. Here, I also use phenolsulphonic acid, full strength, as was used above for reasons mentioned. A 5 per cent. solution of dichloramin-T, as has been elsewhere recommended, may also be employed. After this my treatment is the same as previously given for a dental granuloma.

Technic of Using Dichloramin-T for Sterilization.—The use of dichloramin-T for the sterilization of root canals has been suggested by Prinz and others. The technic is simple. After the chemico-mechanical cleansing of the canal, it should be washed with sterile water and dried; thus removing all of the chemicals previously used in the canal. Now a suitable paper cone is saturated with a 5 per cent. dichloramin-T-chlorcosane solution, carried into the canal, and with a pumping motion an effort is made to coat the walls with the solution; and, if possible, a droplet is permitted to escape into the periapical area. A fresh point, slightly moistened in the solution is then slowly forced into the canal to the end and immediately sealed. The first dressing should remain 24 hours, when the cone is removed and if no discoloration is observed, the canal is filled. Should there be a discoloration of the cone, a second or third treatment is indicated. It will rarely be found necessary to make a third application, if the initial chemico-mechanical cleansing of the canal has been properly done. In using Dichloramin-T solutions in dentistry for any purpose, it should be used alone and with care for the agent is decomposed by water, alcohol, phenol, formocresol, iodin, mercury bichlorid, acids, and

most other chemicals. Its nonirritant properties are dependent, therefore, upon the judgment with which it is used. It should never be injected into a so-called granuloma or abscess, unless the latter was afforded free drainage.

Ionization.—Some of my readers may be surprised that I could discuss at this time the treatment of dental granulomas or alveolar abscesses without the mention of the so-called *ionization method.* The intimation has gone out from different sources that unless ionization is employed in the treatment of these conditions, a cure will not be effected. I want to brand any such intimation as being absolutely erroneous. There are many chemic agents which act as cauterants and stimulants and which may be relied upon to eradicate "this pathologic growth at the end of the root." Much, of course, will depend upon the extent of the destruction of the pericemental membrane and the consequent amount of denuded root-end as a result of the granulomatous growth. As stated above, for years I have advocated and used phenolsulphonic acid for both the nonpurulent and pus-discharging varieties; and I desire to state that I have been curing these conditions. I do not wish to imply that phenolsulphonic acid is the only agent that will accomplish favorable results; but it is the one I have successfully used. What a dismal old world this would be if there were only one royal road to success in any line of human endeavor! I do not object to anyone using so-called ionization. I know results may be obtained by the proper use of the method; but I do object strenuously to the opinion which is prevalent in some quarters that those who are not using this method are failing to cure their cases. My plea is for simplicity of treatment. Complicated methods are expensive, in many cases prohibitive to the patient, and always unnecessary. If the case can be cured at all it can be cured by simple means of treatment.

Ionic Theory.—Now let us discuss the ionic theory from the chemic and pharmacologic viewpoint. Ionization in chemistry means the act of dissociating the ions of a salt or compound by passing it in solution or by means of the electric current. The men who have been attempting to cure, and I want to say that in many instances they do cure, dental granulomas or alveolar abscesses by dissociating the ions of certain salts—notably zinc chlorid, with the electric current—have been taught by Rhein, the most ardent advocate of the method in the United States, that results are obtained by virtue of the *infected tissues in the area being sterilized by the so-called ionization.* Price, of Cleveland, takes issue with Rhein on this point; and states that he had aspirated in many cases after using the

current by Rhein's method and that he was able in nearly every instance to make a culture from the germs thus obtained from the area supposed to have been sterilized. The aspiration was done immediately after the current and salt solution were employed. This does not prove that we cannot cure these conditions by this method of treatment. Rhein and others have proved conclusively that such conditions can be so cured; but it does prove that the results are not obtained by complete sterilization as claimed. Price further makes the statement that ionization as such cannot be accomplished in the manner explained by Rhein; and Price is of the opinion that what is really done by the current in these cases is *cauterization of the affected area*. The result is more likely to be *stimulation* than *cauterization*. The point I wish to make is this: If cauterization or stimulation of the tissues involved will effect a cure in so-called dental granulomas or alveolar abscesses, as I and many others know it will, the proposition resolves itself into the question: What is the most practial and effectual means of bringing about this result? It is simply a question which each one must decide for himself; and each should use those agents and methods which in his hands offer the greatest opportunity for success. It is wrong for any man, especially one who is looked upon as an authority, to claim that there is only one method or means of accomplishing definite results, and that that method is the one which he champions, and perhaps has originated. It is wrong because it is not true; and, not being true, it is discouraging to the thousands of men in the profession who are anxious to do honest, conscientious root-canal work, but who are absolutely at a loss at this time as to just how good work may be done. We need here, as in all lines of dental practice, a standard on which we may all agree.

In recent years much has been written about the health-value of removing focal infection. This is all important, but I wish to state, with all the emphasis at my command, that the majority by far of teeth thus involved may be therapeutically or surgically treated so that they will not be a menace to the health of the individual. Physicians and dentists should work together and in harmony on this proposition. The former should not advise the extraction of teeth without first consulting the latter. When focal infection is found or suspected in the mouth by the medical practitioner, his plain duty lies in referring the patient back to the family dentist with such suggestions as he may deem advisable in the case; and the dentist's duty lies in *removing the focus of infection* by treatment or extraction. The members of the two professions should

work together harmoniously for the benefit of the patient's health, which is being done to-day.

In this connection it is interesting to read the conclusions of Dr. Percy R. Howe, after an extended study of the focal theory of infection.[1] He says, "The experimental evidence that supports the theory of teeth being the cause of general diseases does not represent what actually takes place in the human body. All the effects thus produced and described may be produced in other and more natural ways and more uniformly. The theory is not supported clinically. The teeth are a necessary part of the body. The disturbances about the teeth are as amenable to treatment as is a similar condition in any other part of the body. An infinite amount of harm has resulted from the acceptance of this theory, and but little good.

"Clean up all diseased areas, avoid chemical, mechanical and surgical trauma. Do not regard every difference in light and dark as revealed by the *x*-ray a sign of disease. Many of these areas are cicatricial tissue and have already been taken care of by Nature. Clinical signs are to be regarded first. Make an intelligent effort to save all teeth. Do not regard all bacteria as disease producers. Look to tissue condition as the controlling factor. Persons with no teeth have general troubles fully as much as poeple with teeth. More gastric ulcer is caused by the lack of teeth than through dental disease.

"We are at present suffering from a professional neurasthenia. Every mole hill seems a mountain. We eliminate all other factors, such as normal living, a good sane diet, rest, fresh air, nervous disturbance, high tension living, and see only the infections. Let us hope that dentistry will maintain its sense of proportion, its equilibrium, and let us take a sound, broad and comprehensive view of the problem of physiology and of disease before the present ruthless sacrifice of teeth extends further."

These are wise and cautious words from a sane and practical author and practitioner and should be heeded. And what is of even greater significance, Dr. Howe has not left us floundering in the dark; but has worked out an original and practical method of treating pulpless teeth which is here detailed.

Howe's Method of Treating Pulpless Teeth.—This method is known as "metallic silver reduction;" and by its use, it is claimed, all the various diseased canals are sterilized and blocked by the finely divided metallic silver, no matter how fine they may be. By this

[1] Journal Nat'l Dental Ass'n., Vol. VII, p. 641.

means also the diseased tubuli are also sterilized and filled. The material being selective in action, it will not enter sound tissue because of the coagulable material therein contained. In order to use the method intelligently certain principles governing the action of the drugs used in the solutions must be well understood. Dr. Howe's technic is here given in his own words.[1]

Preparation of Material.—Two solutions are necessary, one containing silver in such a form that it may be quickly and fully precipitated; the other containing the agent producing the precipitation. The first is a solution of silver oxid in ammonia; the second is a solution containing the reducing agent and may be any one of a number of organic materials. Eugenol is one of these, and a very good reducing agent. This leaves a rather thick sediment, is slow in action and does not have great penetrating ability. I prefer formalin, for formaldehyd is very penetrating, and it also produces a high degree of sterility. The great sterilizing power of this method of treatment is not due either to the silver solution alone or to the formaldehyd, but to the reaction between the two. Its effect is immediate. The first solution is prepared by just covering silver nitrate crystals with water, and dissolving them by the aid of heat. When dissolved, add strong ammonia. This throws down a black precipitate of silver oxid. Continue adding ammonia until the liquid almost clears. Do not allow it to quite clear up, because we wish to have no excess of ammonia. Pour off the clear fluid on top and preserve it in dark glass bottles for use. The other solution is simply one part formalin and three parts water, making a 10 per cent. solution of formaldehyd. This solution is kept in another bottle.

The formula that I have given for these two solutions is as follows:

Solution A.—Three grams silver nitrate crystals; 1 cc. distilled water; 2.5 cc. 28 per cent. ammonia. Dissolve the silver nitrate in the water with heat; then add the ammonia and filter. Keep in dark glass bottles.

Solution B.—One part formalin (40 per cent. solution of formaldehyd); 3 parts water.

Other solutions needed are:

A varnish consisting of rosin and alcohol, of a fairly thick consistency. Stain remover—a strong solution of freshly prepared potassium iodid, followed by alcohol or ammonia.

A cleaner for bottles and glassware—a saturated solution of potassium bichromate in strong sulphuric acid. The containing

[1] Journal N. D. A., Vol. VII, p. 855.

bottles should first be filled with this solution and allowed to remain over night. The solution should then be emptied back into the stock solution and the bottles washed thoroughly, preferably with distilled water. This is a common laboratory cleaning solution for chemical work. It is also an excellent idea to clean all bottles in this way that are intended to hold our medicaments.

Instruments for Application.—Dr. Hamilton, of Boston, has designed some instruments for use here that are very convenient. One consists of curved glass tubing. Attached to one end is a small piece of rubber tubing, and into the other end of the tubing is placed a glass rod. By squeezing the tubing a quantity of the solution may be taken up. When the pressure on the tubing is released a small drop of the solution is discharged. Two of these instruments are necessary—one for each solution.

Another instrument that Dr. Hamilton has devised is a small loop of a wire which is inserted in a handle. This, too, is convenient for handling the solutions. He has also suggested using something like a drawing pen. The operators in the Forsyth Infirmary are adept at picking up the solution in their pliers held slightly open. Other ideas will occur to various operators.

Smooth square-sided applicators, similar to Swiss watch broaches, are good. A swab of cotton nicely rolled about one of these makes a good instrument with which to varnish the tooth. It is also suitable to remove air-lock and assist in an accurate placing of the solutions in the tooth. Cotton points are also very useful in the application of these solutions.

Principles of Its Use.—In using this method it is essential that the operator dismiss from his mind all mechanical ideas. The futility of depending upon mechanics is realized when we know the many bifurcations which are found near the end of the root, and also the lateral openings leading from the main canal. This I have shown by treating teeth with silver, in the manner about to be described, decalcifying the teeth thus treated in hydrochloric acid, clearing them up in acetic acid, and still further in xylol, and mounting them in Kaiser's Jelley. This renders the teeth transparent, when all the many bifurcations and openings are clearly shown filled with the reduced silver. In this method we rely on chemic and physical principles. This material is intended for use within the tooth. We are trying to reach the minute anatomy of the tooth, ramifications and all diseased organic matter.

The principles of capillarity are relied upon. No broach should ever be placed more than one-third the way up a canal. The

material will flow up a canal if air-lock is removed and enough of the solution is used. *There should be no pain whatever.* The pain is due wholly to the operator's procedure. He has passed the material through the apical region.

Method of Procedure.—A. In case of a gangrenous pulp, apply the rubber dam. Prepare a strong edge to the cavity. Clean out the bulk of debris. Dry and apply varnish, covering entire tooth and painting the inside of the tooth walls down to the pulp chamber. Dry on the varnish. Now fill the tooth cavity full of the silver solution. Allow it to remain for about three minutes. If it is taken up by the tooth apply more. The object is to saturate the diseased tooth structure and pulp with it. Then add to this the formalin solution and mix it a little in the cavity, allowing it to remain a minute or more. Absorb the solution out with cotton or absorbent paper. Repeat with another similar application. This is to furnish more metallic silver. The region reached is sterile. Absorb again, and reapply solutions, allowing them to enter root-canals. It is unnecessary to go through an elaborate procedure to obtain sterility. The sterilizing agents are in the field of operation. The gangrenous pulp becomes sterile in a few moments and the instruments working in this material are sterilized by it. Dry and remove the bulk of gangrenous material. Reapply the solutions. Allow them to remain about three minutes, dry out and put in eugenol, desiccating this with warm air. The tooth is sterile and blocked by finely divided silver in a most perfect manner. Fill with anything you like.

Finally apply the solution of potassium iodid to remove the possibility of stain from any remaining silver solution. Take off the varnish with alcohol.

B. In a case with one gangrenous canal and one with sensation proceed as in A, but work the material with a broach into the canal that contains vital tissue. This may cause momentary discomfort, but it is slight, and lasts but a very few moments. In both cases all organic matter is not removed. In no canal is all organic matter ever removed. But remove as much as you can. By this treatment any remaining becomes a stiff dry mass of sterile albuminate of silver.

C. In case of an abscess, treat as in A once, so as to remove the original cause of the trouble, syringe through the abscess or into it with Dakin's solution, as often as possible. If there is no opening into the abscess, make one either through the root-canal or gum and wash out with Dakin's solution. Dakin's solution, physiologic salt solution or drainage is the proper treatment for the cellular tissues.

The silver is for the dentin and tooth proper. As soon as the abscess heals, apply the silver as in A several times, and fill.

D. For pulp capping, do not remove the decalcified material over the pulp. Each dentinal capping has been individually laid down by its odontoblasts. Cover the floor of the cavity with a cement of zinc oxid and eugenol. In posterior teeth mix a few crushed crystals of silver nitrate into the zinc oxid and eugenol. This aids in hardening the cement. (Dentinoid may be used to advantage here—Author.) After hardening a little apply the silver treatment. All the affected dentin is thus sterilized and filled, even when the affection is microscopically fine. Pulps are very vascular. They, therefore, have great recuperative power both as to disposition of infection and as to tissue repair.

E. Treat all dentin and caries with this material. It will seek out unsuspected areas that are affected, sterilizing and blocking them. It will not enter sound structure. No cavity is sterile after excavation by the bur. Excavate as little as possible consistent with filling retention and sterilize. This saves mechanical destruction of the tooth with the eventual pulp death and still subsequent need for canal work.

It is frequently asked if this metallic silver shows in *x*-ray work. It does, but only in part. The radiogram is too diffused to show it in every part. In my opinion the *x*-ray is relied upon too much for the interpretation as to what is correct and what is not in our work. Neither infection nor pus can be told by the *x*-ray—light and darkness only are distinguished. A darkened area no larger than a grain of rice does not mean an abscess. These are usually thickened cicatricial tissue. It is Nature's repair work that has followed the disturbance created by our efforts at treatment. Larger areas which show signs of swelling or crepitation should, of course, be opened and cleared up. The appearance following this treatment is a close filling in of tissue about these roots. The treatment which we have described is simplicity itself. It is scientific, and I believe the most perfect yet developed. The discoloration is a disadvantage. There should never be any pain, and when it follows it is wholly due to a faulty method of handling the material. Grasp the principles of application and the rest is very simple (Howe).

The inflammation which sometimes follows the use of Howe's treatment may be avoided, according to John A. Marshall, of San Francisco, by substituting a solution of crystal violet and brilliant green for the silver preparation. The solution is claimed to penetrate the tooth structure with even greater facility than does the silver

solution and, apparently, its antiseptic power is of equal value. Dr. Marshall's researches along histologic lines have lead him to conclude that the dentin and cementum are distinct structures without communicating fibres. Considered in its relation to the treatment of pulpless teeth, this is an important finding; and this author has contributed much to the literature on this subject. His work on the extent of infection to which the dentin is liable; methods of sterilizing infected dentin; and the possibility of maintaining a permanent sterilization, should be read and studied by every student and practitioner interested in the conservation of pulpless teeth (see Index of Dental Literature).

COMPLICATIONS.—Occasionally we encounter complications in the treatment of pulpless teeth. These will now be considered.

Badly Decayed Root.—Formocresol is very destructive to the soft tissues of the mouth, therefore the importance of always adjusting the rubber dam. If this cannot be done on account of a badly decayed root, it is suggested that care be taken in sealing the remedy in the cavity at the first sitting, and, in placing the cement, the original outline of the root can be approximated. After the cement has set, a band or matrix of gold or German silver can be fitted to, and cemented on the root. In doing this it is best to use a cement of different color from that employed for treatment purposes; and in treating the case where there is a tooth posterior, it is best to place a clamp on this tooth, gently stretch the rubber over the band and thereby avoid loosening it. With the complication thus removed, the treatment is the same as previously given.

Pulp Partially Alive.—In those cases where the pulp tissue is gangrenous in one or more canals of a multirooted tooth and alive in the other one or two canals, as the case may be, we will find much satisfaction in using the formocresol remedy (Fig. 34). These are exceptional cases and it is difficult to know whether this condition exists until the second sitting. If there be much vitality in the live pulp tissue, the formaldehyd in the remedy will doubtless make the tooth ache, but after we know the conditions our method of procedure is simple, and the results will be certain. A small pledget of cotton dipped in the remedy can gently be placed over the mouths of the canals which contain gangrenous material, and a thin quick-setting cement flowed over the cotton. After the cement has set, the live pulp tissue in the remaining canals can be anesthetized or devitalized, as the operator deems best at the time. These remnants of pulps may generally be desensitized and removed with very little pain by gently working phenolsulphonic acid up or down the canal

with a fine broach. Formerly these were difficult cases to treat, but with a remedy which can be hermetically sealed in a gangrenous root-canal, the procedure is materially simplified.

Pulpal Abscess.—It was previously mentioned that one may occasionally open into a suspected tooth, having all the symptoms of a dead pulp, and find a drop of pus in the bulbous portion of the pulp with the remaining portion still alive. Some writers call this condition a *septic pulp* or *pulpal abscess* in contradistinction to *gangrene* or *true putrescence* (presence of gases). In such a case, any remedy containing formaldehyd may cause the tooth to ache; therefore, this must be taken into consideration, and in the treatment of so-called septic pulps, the pus should be washed out of the cavity with a warm antiseptic solution, the cavity dried, and asepsis established by hermetically sealing in a much smaller amount of formocresol than that generally used in cases of true *gangrene*. If this precaution is taken the tooth will not ache long, even in cases where no odor is present and the vital tissue is still quite sensitive. This remedy will sterilize the tissue, after which, at the second sitting, the pulp can be anesthetized or devitalized as usual.

Dry Gangrene.—Sometimes on opening into a pulpless tooth we find the canal dry and odorless. This condition is called *dry gangrene* of the pulp. It is not really a complication if we recognize that microorganisms may be present and seal a disinfectant in the canal for at least twenty-four hours. One treatment of formocresol or phenol compound will correct any possible trouble, when we are ready to use phenolsulphonic acid, after which the canal can be filled.

The several methods of treating pulpless teeth have here been outlined; and the practitioner may select the one which best meets his requirements. With the knowledge we have to-day of the dire results of focal infection; and with the *x*-ray showing that the root-ends of pulpless teeth in so many instances are foci of infection, it becomes necessary to either improve our treatment or extract these teeth. There is absolutely no justification, however, for the ruthless and radical extraction of the past few years. Patients everywhere are fast learning this significant fact. The following cases from the author's practice, treated in the manner described, speak for themselves.

HISTORY AND TREATMENT OF PRACTICAL CASES

Series No. 1

Patient.—Female. Age, about 33 years; of a nervous temperament, and not in good physical condition. Had suffered more or

less from neuralgia. All teeth extremely hypersensitive. Picture for Fig. 35 was taken February 2, 1916.

Treatment.—The excementosed second bicuspid was extracted February 21. (Fig. 36.) The porcelain crown was removed from the first bicuspid on February 28th, and formocresol sealed in canals. On March 1st the canals were cleansed and opened with xylol and phenolsulphonic acid, when diagnostic wires were placed in canals and picture for Fig. 37 taken. The canals were filled on March 6th, when pictures for Fig. 38 and Fig. 39, showing two views of root-filling, were taken.

Series No. 2 (*a* and *b*)

Paitent.—Female. Age, about 32 years. Presented in March, 1916, suffering with intermittent, radiating pains in the back of her head and both sides of her neck. The general condition of the patient was good, except that she was rather depressed from overwork. She had had several radiograms taken the preceding September. A nonpurulent dental granuloma was disclosed on the lower second bicuspid on either side. Fig. 40 of this series shows the granuloma on the lower right bicuspid.

Treatment.—(*a*) Removed porcelain crown on March 1st and sealed formocresol in the canal. On March 3, the canal was cleaned and opened with xylol and phenolsulphonic acid and eucalyptol compound sealed in. The canal was filled on March 8, when picture for Fig. 41 was taken. The tooth was giving no local trouble, apparently, when treatment was begun; nor was any soreness manifested throughout the treatment. Picture for Fig. 42 was taken July 11, about 4 months after the canal was filled. Picture for Fig. 43 was taken September 25, about 6½ months after root-filling operation. (*b*) Picture for Fig. 44 of this series shows the granuloma on the lower left bicuspid. As was mentioned of the tooth on the opposite side of the mouth, this tooth also was giving no apparent local trouble when treatment was begun. The gold crown was removed on March 4 and I immediately worked to the end of the root with xylol and phenolsulphonic acid. Sealed eucalyptol compound in the canal. Patient returned March 8, giving history of acute apical pericementitis, which was still in evidence. Placed diagnostic wire in the canal with formocresol dressing, when picture for Fig. 45 was taken. On March 14 the soreness had entirely subsided, when canal was filled. This case illustrates the value of the initial formocresol dressing, which you will notice was not used here. Picture for Fig. 46 was taken July 11, about 4 months after

root-filling operation. In the meantime the lower left first molar, carrying a gold inlay which restored nearly the occlusal third of the crown, became uncomfortable, though the radiating pains in the back of head and neck had completely disappeared. Fig. 46 shows also the diagnostic wires after devitalizing and removing, by the aid of phenolsulphonic acid, an almost completely calcified pulp. Picture for Fig. 47 was taken September 25, about 6½ months after root-filling operation on bicuspid, and 2 months after that on the molar.

Series No. 3

Patient.—Male. Age, about 40 years. Nervous, not in good physical condition. An upper right first molar had been treated and filled about 3 months previous to the time patient was referred. Complained that his tooth "had never felt right since it had been treated." Picture for Fig. 48 was taken May 26, 1916, before I saw the patient.

Treatment.—On June 10, the amalgam filling was removed, as was also the old root-filling, using xylol and phenolsulphonic acid. The lingual canal seemed blocked and a false pocket had been made. The canal proper appeared to be blocked with undecomposed pulp tissue. I used a saturated solution of sodium hydroxid and in 5 minutes' time, with a small twist broach, the end of the root was reached. The alkali was then neutralized with phenolsulphonic acid. Time consumed for entire operation at this sitting—one hour. I mention this here simply to show that if we go at these cases in an intelligent manner, it does not require as much time as some operators have led us to believe. The diagnostic wires were also put in at this sitting with a dressing of eucalyptol compound, when picture for Fig. 49 was taken. This picture shows that the wire in the mesio-lingual canal was not in as far as the canal had been explored, or else, as proved to be the case, the canal was not properly opened. Patient returned June 16. Thinking undecomposed pulp tissue also blocked the mesio-lingual canal, the saturated solution of sodium hydroxid was used. In 3 minutes' time the end of the root was reached. The alkali was neutralized with phenolsulphonic acid, canals desiccated and filled. Ordered radiogram for Fig. 50. The patient called when he was in the city, late in September, and reported tooth entirely comfortable.

Series No. 4

Patient.—Female. Age, about 45 years. Physical condition very good. Presented May 5, 1916. No pain or discomfort of any

Fig 35

Fig. 36.

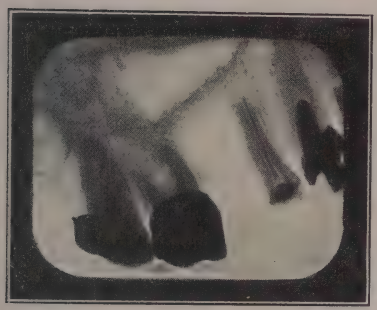

Fig 37

Fig 38.

Fig. 39.

SERIES No. 2. (*a*)

FIG. 40.

FIG. 41.

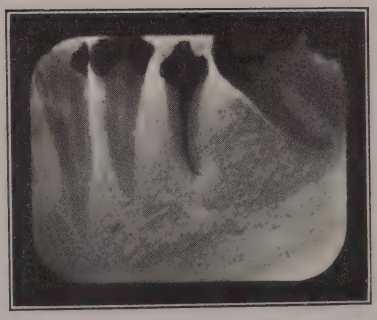

FIG. 42.

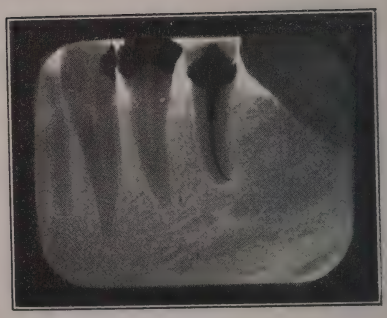

FIG. 43.

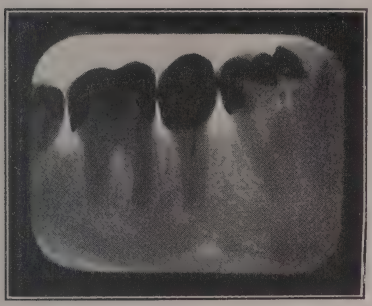

FIG. 44.

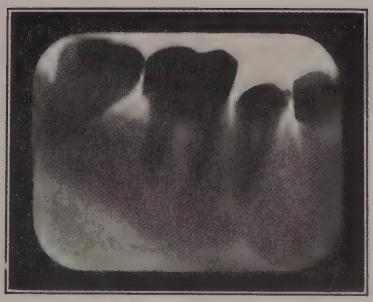

FIG. 45.

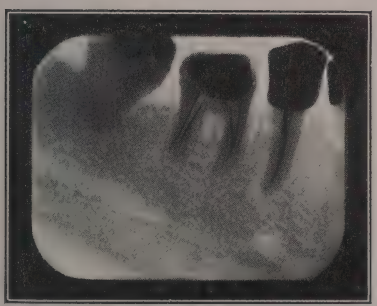

FIG. 46.

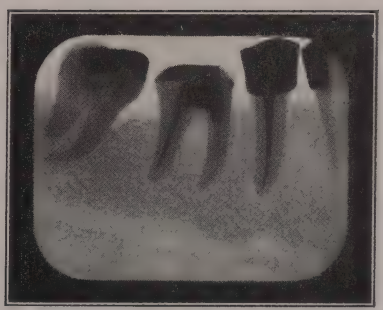

FIG. 47.

Series No. 3.

Fig. 48.

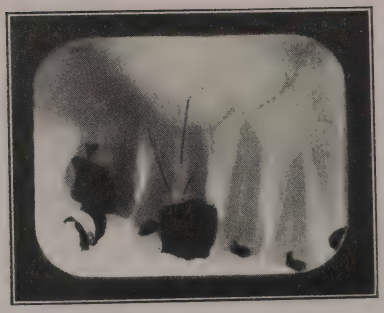

Fig. 49.

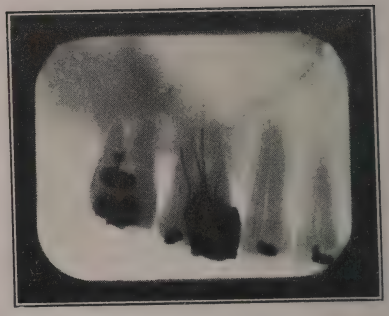

Fig. 50.

kind; but she had noticed a discharging sinus in the region of the apex of the upper left second bicuspid. So far as patient knew, the abscess had been standing for about 2 years. Ordered radiogram for Fig. 51.

Treatment.—Opened into the pulp chamber on the above date (May 5) and cleaned canal with phenolsulphonic acid, working the same through end of root and sinus, after using physiologic salt solution. As there was a bad odor, formocresol was sealed in the canal. On May 8 the canals were filled and picture for Fig. 52 was taken. Picture for Fig. 53 was taken January 4, 1917.

Series No. 5

Patient.—Male. Age, about 55 years. Blood-pressure abnormally high, and occasionally had spells of dizziness. Two involved teeth were extracted and treatment for upper lateral was given as follows for gangrenous pulp.

Treatment.—On May 31, 1916, the canal was exposed and a dressing of formocresol sealed in. The patient could not return until June 29, when the canal was cleaned and enlarged with phenolsulphonic acid, and unexpectedly an abscess sac was ruptured and pus, thick and yellow, with streaks of blood, flowed freely from the canal. The discharge was checked, the acid worked through the end and formocresol sealed in the canal. On this date (June 29) picture for Fig. 54 was taken. Patient did not return, owing to absence from city, until July 20, when the root-filling was inserted. Picture for Fig. 55 was taken September 9, about 7 weeks after root-filling operation and about 9 weeks after the pus was noticed. Picture for Fig. 56 was taken December 30, 1916. This case illustrates the advantage of the radiogram in the treatment of all cases of pulpless teeth. Notice how the fluid gutta-percha escapes through the multiple foramina.

Series No. 6

Patient.—Male. Age, about 38 years. The vital teeth in picture for Fig. 57 had carried an inlay bridge for several years. Decay had progressed under the molar inlay, and when patient presented the pulp of this tooth was highly congested and aching severely.

Treatment.—On Sept. 5, 1916, when I first saw the patient, the pulp was caused to bleed and phenol compound sealed in the cavity. On Sept. 7 the patient returned giving history of the tooth being comfortable. At this time the bridge was removed and devitalizing fiber applied. On account of my leaving the city and the patient

being a dentist, the arsenical dressing was left for one week, with instructions to remove the same in case the tooth manifested soreness. This was not necessary and the patient returned on Sept. 14. Contrary to my usual custom of using formocresol after a pulp has been poisoned with arsenic trioxid, I removed the pulp at this sitting and cleaned the canals with phenolsulphonic acid. Eucalyptol compound was then sealed in, and on Sept. 18 the canals were filled. Picture for Fig. 58 was taken Oct. 5.

In Fig. 59 we find a good illustration of the care that should be taken in the interpretation of dental radiograms. There is shown a dental granuloma on the mesial root of the lower molar, as was subsequently verified by treatment; but the point to which I desire to call especial attention is the dark line parallel with the distal root. This might be mistaken for a gutta-percha point passing through a punctured root. Closer examination will show that something on the film, having no relation to the tooth, produced the shadow, for the line curves upward and may be noticed distal to the gold crown. Radiograms are a great aid in dental diagnosis, but they are by no means positive. Many things must be considered in their correct interpretation.

Series No. 7

Patient.—Female. Age, 11 years. While playing at school, an accident occurred on Oct. 20, 1916, in which both upper central incisors were broken off—one exposing the pulp, the other being nearly exposed.

Treatment.—The pulp in the left central, which was exposed, was carefully anesthetized by pressure anesthesia and removed by the family dentist. The pulp in the right central (not quite exposed) was removed under nitrous oxid-oxygen anesthesia. As the roots were not fully formed and the apices were large, the patient was referred for the root-filling operation. Picture for Fig. 60 was taken Oct. 21, after both pulps had been removed. On Oct. 24, both canals were cleaned with phenolsulphonic acid and eucalyptol compound was sealed in with double sealing. The root-filling operation in the left central was done on Oct. 26; in the right central on Oct. 30, when picture for Fig. 61 was taken. The root-filling was covered with zinc oxychlorid cement, as is my practice where it may be done, and the patient referred back to the family dentist with the suggestion that porcelain jacket crowns be made which would not disturb the root-fillings.

Series No. 4.

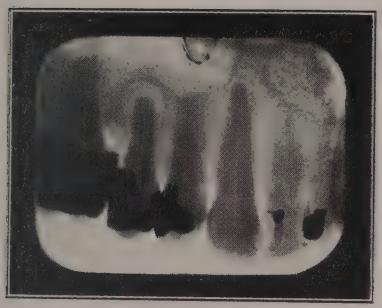

Fig. 51.

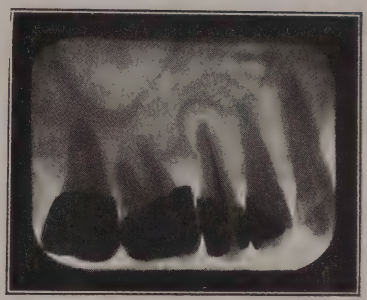

Fig 52

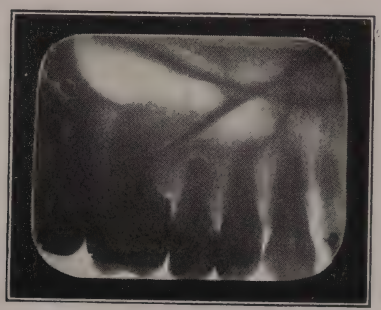

Fig. 53.

Series No. 5.

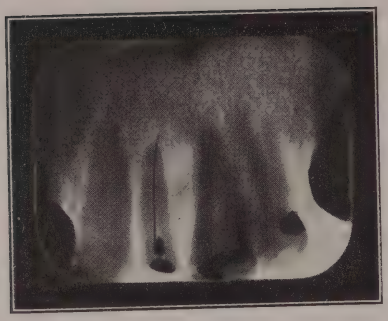

Fig. 54.

Fig. 55.

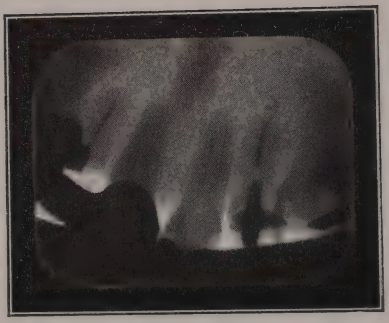

Fig. 56.

Series No. 6.

Fig. 57.

Fig. 58.

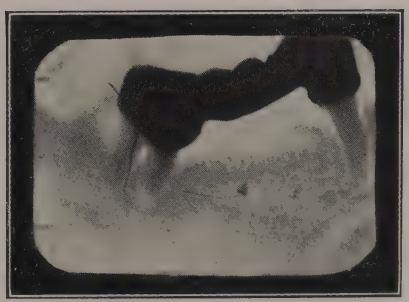

Fig. 59.

Series No. 7.

Fig. 60.

Fig. 61.

The following two cases are from the practice of the late Dr. J. F. Biddle, Pittsburgh, Pa.

Series No. 8

Patient.—Female. Age, 22. Presented with a badly swollen upper lip, nose and surrounding tissues. The tissues were so distorted that it was difficult to tell where the lip ended and the nose began. In the preceding 48 hours she had had chills and fever intermittently and her temperature at this sitting was 102½°.

Treatment.—On account of her extreme nervousness, it was impossible to make an oral examination at this time; hence, nitrous oxid and oxygen were administered and the soft tissues at the junction of the lip and gum were lanced, about 45 minims of a thick yellowish-green pus being removed, after which the cavity was irrigated with physiologic salt solution and injected with 10 minims of tincture of iodin. The patient was instructed to take a dose of Epsom salts and to keep an ice bag over the affected part. The following day her condition was much improved, temperature 99½°, and upon reopening the wound about 30 minims of pus and blood were removed.

Radiogram for Fig. 62 was taken which shows that, of the four teeth crowned, none of their roots had been filled and all were abscessed. The crowns were removed and a treatment of formocresol was sealed in the canals. On the third day, the canals were opened to the apex with reamers, aided by 50 per cent. sulphuric acid. Upon going through canals at apex of roots there was no sensation, hence wires were inserted, and a second radiogram (Fig. 63) taken, to determine whether all canals had been properly opened. The worst condition was over the right lateral and central incisors, and as it was necessary to restore a healthy condition as quickly as possible on account of the patient's leaving the city, 50 per cent. sulphuric acid was forced through the canals of these two teeth and out through a sinus over the lateral incisor. This was followed by 4 ounces of physiologic salt solution using a 2-ounce syringe with a fine platinum point which was forced into the canal, while the sides were packed with unvulcanized rubber to prevent the return of the fluid.

A second treatment of formocresol was sealed in the four teeth, and allowed to remain for 48 hours. The canals were then enlarged and a third treatment of formocresol (modified) was sealed in for 24 hours, followed by a treatment of oil of cloves which remained for four days. The canals were then filled and a temporary plate which

had been made when the crowns were removed did duty for six months, after which the third radiogram (Fig. 64) was taken. Fearing lest the shadow over the right lateral might be an abscess still existing over this tooth, the soft tissues were injected with procain and a small bur used to enter the bone at the apex of the root, but it was found to be in normal condition and a specimen taken from this location was found to be negative. The fact that this area was not as dense as the remainder of the tract is evidently due to the amount of bone that was removed in enlarging the sinus and the area at the apex.

Four years ago new crowns were adjusted to these teeth, from which time they have given the patient no further discomfort.

Series No. 9

Patient.—Male. Age, 50. Very active—at his desk greater part of the day—conferences, also outside interests—works from 14 to 16 hours daily, hearty eater, moderate drinker. Had great powers of concentration which appeared to be much impaired within the last year. Examination revealed a slight leaking of one of the valves of his heart, gastrointestinal disturbances, also trace of albumin in the urine. *X*-ray examination showed a number of unfilled roots, misfit crowns and periodontoclasia.

Treatment.—The crowns and three teeth were removed. All other partially filled or gangrenous canals were treated and filled and the gums restored to a healthy condition. One tooth, a radiogram of which I shall use to illustrate the regeneration of bone around the apex, was considered hopeless. This tooth was exceedingly loose and when the débris was removed a flow of pus filled the cavity. The pus was evacuated as thoroughly as possible and a specimen was sent to the laboratory. It was found to contain streptococcus fecalis, streptococcus salivarius and streptococcus viridans. A treatment of formocresol was sealed in the pulp chamber. After 48 hours the treatment was removed and the canal was enlarged. Next the canal was cleaned with 50 per cent. sulphuric acid, and a second treatment of formocresol was sealed in for another 48 hours, after which a treatment of oil of cloves was allowed to remain in the canal for a week. The canal was flooded with eucalyptol which displaced the air, this in turn being displaced by chloropercha, followed by a number of fine gutta-percha points, packed until the mass became solid. A crown with very little contour was inserted, which was used as an attachment for a clasp on a plate.

Series No. 8.

Fig. 62.

Fig. 63.

Fig. 46.

Series No. 9.

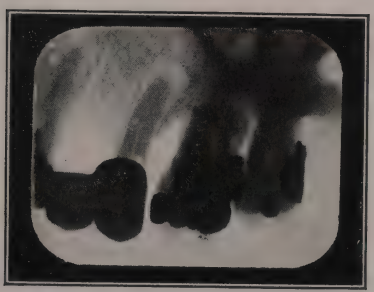

Fig. 65.

Fig. 66.

At the time of beginning of treatment of this case, radiogram for Fig. 65 was taken, and four months later for Fig. 66, which shows the rarefied area at the apex of the root to be filling in with bone in a very gratifying manner. I could cite many other cases with larger denuded areas, but this one I consider one of the most hopeless I ever attempted to treat.

Since the patient's teeth have received attention and his mouth has been placed in hygienic condition his health has greatly improved. Whether or not this improvement be due to the correction of diseased oral conditions, I think we will all agree that abscessed teeth should receive early attention, no matter how or where we may find them.

The following case is from the practice of Dr. L. E. Bake, Chicago, Ill.

Series No. 10

Patient.—Female. Age, 24. Reports at the office with a left upper lateral which had been filled on the mesial surface with so-called "porcelain enamel." The tooth was quite sore and a radiogram, Fig. 67, showed an extensive periapical involvement. The tooth was isolated, pulp chamber and root canal opened and area drained. After drying as much as possible a dressing of formocresol was sealed in the canal, with instructions for patient to return in forty-eight hours. When patient returned, much to my surprise, the secretions had seemingly increased and exuded from the canal in drops, but the tenderness had disappeared. After draining as best I could under the conditions, another dressing of formocresol was sealed in the canal with instructions to return in forty-eight hours as before. These treatments were repeated four times with the same result. It was finally decided to extract the tooth, formocresol was again sealed in; and an appointment was made for extraction. The tooth being perfectly comfortable, and as the patient disliked very much to lose it, she did not return for a period of eight months. The case giving a favorable history, I decided to again remove the dressing and see what had happened. Much to my surprise the dressing was dry and the canal clean. The latter was then enlarged and filled at once with eucapercha and gutta percha cones. The second radiogram, Fig. 68, was taken at this time with results as shown. The third radiogram, Fig. 69, was taken about one year later. Radiogram for Fig. 70 was two years and three months after Fig. 69 or over three years after the root was filled as shown in Fig. 68.

Author's Comments.—This case of Dr. Bake well illustrates several important things in the treatment of pulpless teeth. First, it had every indication of a periapical cyst, which is supposed to be cured only by curettment. Second, it proves that the pericemental membrane is not always destroyed in these extensively involved cases—Hatton, Puterbaugh and others have directed attention to this—a condition which the radiogram does not disclose. Thirdly, it encourages the dentist to undertake the treatment of many of these seemingly hopeless cases, which have been condemned in the recent past. Fourth, it answers the criticism of those who have claimed that formaldehyd remedies should never be sealed in the canal of a tooth. This is as good a case of bone regeneration as one could expect to get by any method of treatment; and while the bone regeneration was taking place formocresol was sealed in the canal. (See also Figs. 31 and 32, page 394.)

The next case is from the practice of Dr. James M. Thompson, of Detroit, Michigan.

Series No. 11

Patient.—Female. Presented with an abscess with a sinus which had been standing for some time. The radiogram for Fig. 71 presents a typical pathologic picture for these chronic cases. There is a rarefied area from the osteitis affecting the lamina dura, but not having completely destroyed the bone trabeculæ. A dark line is also seen around the rarefied area, the result of a condensing osteitis or bone sclerosis—an effort on the part of nature to ward off or hold back the infection.

Treatment.—The tooth was opened and the canal thoroughly cleansed, when formocresol was sealed in, with instruction for the patient to return in three days. For some unexplained reason the patient did not return for a period of six months, during which time the tooth had given no trouble and sinus had thoroughly healed. The dressing was removed and when found clean and dry, the canal was filled at once, when radiogram for Fig. 72 was taken. Notice not only the seemingly perfect root-filling, but the healthy appearance of the bone around the root-end, the reproduction of the lamina dura, and the almost complete disappearance of the dark line produced by the condensing osteitis before treatment was begun; and all this return to normalcy took place *while formocresol was sealed in the canal.* This case is mentioned also on p. 394 and cuts shown there as Figs. 31–32. They are reproduced here that emphasis may be given the above statement for it corrects the

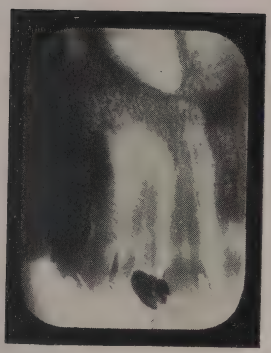

FIG. 67.

FIG. 68

FIG. 69.

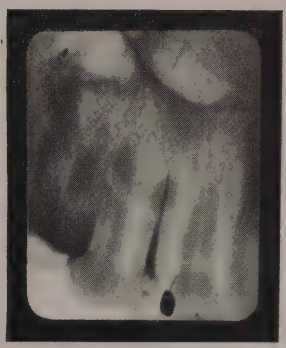

FIG. 70.

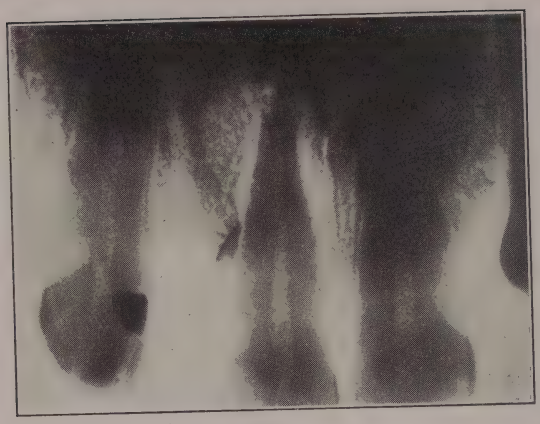

FIG. 71.

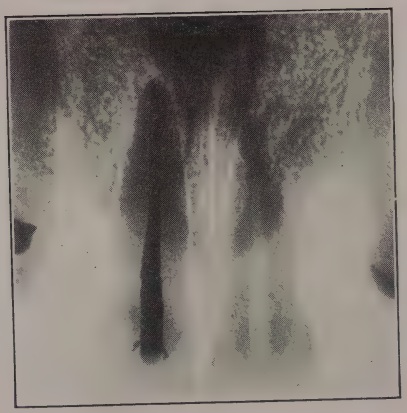

FIG. 72.

impression left by some dental writers that under no condition should formaldehyd preparations be sealed in the canals of teeth. The value and safety of such preparations depend entirely on where and how they are used (see also Figs. 67 to 70).

The next case is from the practice of Dr. Ralph R. Hartley, of Los Angeles, California.

Series No. 12

Patient.—Female. Age, 22 years. Physical condition only fair. Had suffered previously from infantile paralysis. The pulp in an upper lateral had died from too rapid movement in orthodontic treatment. When patient presented an abscess, without a sinus, of about two years standing was found associated with the lateral in question, Fig. 73. From the amount and character of the pus, the patient was advised to have the tooth removed; but not wanting to lose it unless absolutely necessary, treatment was undertaken with no promise as to possible result.

Treatment.—An opening was made on the lingual and pus permitted to drain, using pressure over the end of the root. The canal was desiccated as much as possible and formocresol sealed in. At the next sitting the dressing was removed and phenolsulphonic acid was used to clean the canal—some of the acid being carefully worked through the end of the root. The acid in the canal was neutralized and another treatment of formocresol was sealed in. Subsequently the canal was filled. The radiogram for Fig. 74 was taken about ten months later. Notice the loss of the lamina dura on the distal of the lateral in Fig. 73 and also of the bone trabeculæ in the area involved between the lateral and cuspid; and compare this condition with that shown in Fig. 74.

The next five cases are from the practice of Dr. Chas. G. Hartley of Los Angeles, California; four of which illustrate the use of lead in filling the canals of pulpless teeth. In selected cases Dr. Hartley has been using lead as a root filling for about fourteen years; after seeing the material thus used by Dr. Spaulding, an American dentist of Paris, France, who had followed the method for over thirty years.

Series No. 13

Patient.—Female. Age, about 15 years. Physical condition, good. Presented with a discharging abscess over upper lateral, as shown in radiogram, Fig. 75.

Treatment.—Tooth was opened on lingual and treated in the usual way with formocresol and phenolsulphonic acid. Owing to the amount of bone involvement, it was expected that surgery would be necessary following the therapeutic treatment and root filling; therefore, no precaution was taken to have the lead root filling stop at the end of the root. However, it was decided to wait and give nature a chance. The sinus healed, the tooth gave no evidence of trouble and in about a year the radiogram for Fig. 76 was taken. This shows that the tissues take kindly to lead; though it is not necessary to have the material extend past the root-end, if proper precautions are taken.

Series No. 14

Patient.—Female. Age, about 60 years. Physical condition, fair. Presented with a granuloma on the cuspid which served as an abutment for a bridge. Had been standing for some years. Fig. 77.

Treatment.—Tooth opened and treated with formocresol. Lead point fitted and tried in canal. After coating the canal with eucapercha compound, the point was malleted home. Radiogram for Fig. 78 was taken about one year later.

Series No. 15

Patient.—Female. Age, about 26 years. Nurse, in good physical condition. Granuloma on mesial root of lower first molar. Fig. 79.

Treatment.—Treated in usual manner with formocresol; after which the distal root was filled with gutta-percha and the mesial root with lead. Radiogram for Fig. 80 was taken about 8 or 10 months later.

Series No. 16

Patient.—Female. Age, about 25 years. Physical condition, fair. Pulp died in central incisor from blow. Chronic abscess of five or six years standing. Fig. 81.

Treatment.—The tooth was treated with formocresol and phenolsulphonic acid. Fig. 82 shows a lead point in the canal for measuring length and determining size of the opening through the end of the root. After the canal was filled with lead, an opening was made through the soft tissues and bone to expose the root end, when the lead was burnished. Fig. 83 is from a radiogram taken about one

Series No. 12.

Fig. 73.

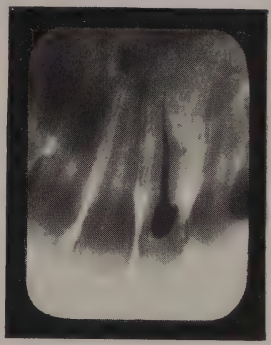

Fig. 74.

Series No. 13

Fig. 75

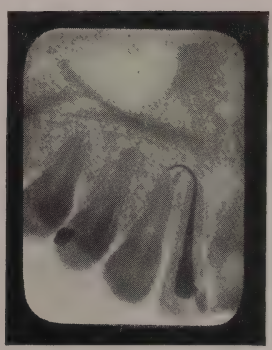

Fig. 76.

Series No. 14.

Fig. 77.

Fig. 78.

Series No. 15.

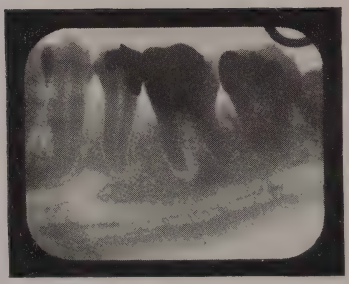

Fig. 79.

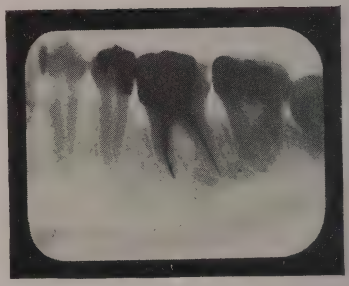

Fig. 80.

Fig. 81.

Fig. 82.

Fig. 83.

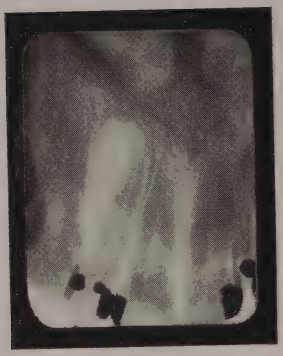

FIG. 84.

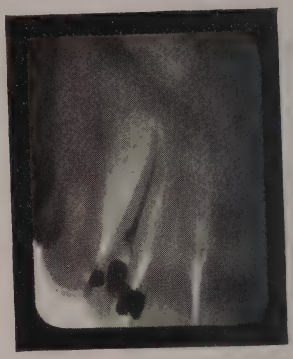

FIG. 85.

FIG. 86.

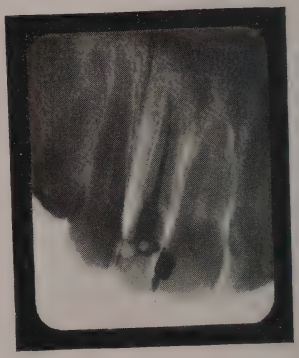

FIG 87.

year later. In the meantime the pulp in the lateral had died, which was treated and canal filled with gutta-percha.

Series No. 17

Patient.—Female. Age, about 40 years. Physical condition, good. In this case the author was consulted and both Dr. Hartley and myself recommended the removal of the tooth on account of the large area of bone involved, with evident loss of lamina dura. The tooth in question being an upper lateral incisor, the patient demurred and wanted it treated. Without any promise as to results, Dr. Hartley undertook the treatment. Fig. 84.

Treatment.—The canal was opened Oct. 28, 1922 and formocresol sealed in. In a few days following this phenolsulphonic acid was used in the usual manner and the canal was filled with gutta percha on Nov. 16, 1922. Fig. 85. The radiogram for Fig. 86 was taken Jan. 29, 1924, and for Fig. 87, Oct. 8, 1925.

The next two cases are from the author's practice.

Series No. 18

Patient.—Female. Age, 45 years. Physical condition, good. The upper right lateral had been pulpless and canal filled in about 1897, before the days of the *x*-ray. Two or three years after the root-canal operation, the crown of the tooth was bleached by the author and a gold filling inserted. Slowly, but gradually the tooth darkened; and it was decided in May, 1919, to adjust a porcelain jacket crown. At this time radiogram for Fig. 88 was taken.

Treatment.—On May 16, 1919, the gold filling was removed and the mouth of the canal was exposed, when formocresol was sealed in contact with the old gutta-percha root-filling. This remained for two days, when xylol was used to remove the gutta-percha in the canal and the latter cleansed with phenolsulphonic acid. This was neutralized with sodium bicarbonate (10 per cent.), the canal desiccated and formocresol again sealed in. This is contrary to the usual method; but owing to the necessity for hurrying the treatment, and not wanting the tooth to get sore, formocresol was used again. Two days later the canal was filled when radiogram for Fig. 89 was taken. The following day the root was prepared and a porcelain jacket crown was made and cemented to place. Radiogram for Fig. 90 was taken about a year later and the last radiogram, Fig. 91, was taken July, 1923, four years after the canal operation. The tooth had never given the least trouble during all the years it had been pulpless; nor did it manifest any soreness while under the

treatment as outlined. This case is only one of many in the author's practice which demonstrates that these cases can be handled without soreness during treatment, and that formocresol may be safely sealed in the canals of teeth, if properly done.

Series No. 19

Patient.—Male. Age, about 50 years. Patient had always enjoyed good health until now. He was a hard worker and never took a vacation or any exercise. Shortly before being referred he had suffered a severe nervous collapse. There were only two pulpless teeth in his mouth—an upper lateral incisor, seemingly not involved, and this lower second bicuspid. Fig. 92. It will be noted from the picture that the lamina dura is destroyed and one might suspect an involvement of the root-end. There was no sinus. With the patient suffering from systemic involvement, it would seem the plain duty of the dentist to extract such a tooth as is shown here; but the patient did not want to lose the tooth—the referring dentist and physician both left the responsibility for disposing of the infection wholly to me. The patient was given no promise as to possible result, and treatment was undertaken.

Treatment.—The tooth was opened aseptically and formocresol sealed in for two days. Canal was then cleansed with phenolsulphonic acid and a drop or so worked through into the granuloma. Eucalyptol compound was then sealed in, using the double sealing of temporary stopping and cement. After three days, the canal was filled and radiogram for Fig. 93 was taken. The radiogram for Fig. 94 was taken three years after the treatment and root-canal operation. Note the reproduction of the lamina dura, and bone trabeculæ. The patient has fully regained his health. This case emphasizes the fact that the radiogram does not always portray the truth. Surely the root-end was not involved as one might be lead to believe from the first picture—nor was the pericemental membrane destroyed, or we should not have had the bone regeneration as shown in last radiogram.

In Fig. 95 we have a case treated by Dr. Hart J. Goslee, of Chicago. The pulp had died under a filling in the upper second bicuspid. Without the aid of the *x*-ray, the tooth was treated with formocresol and the canals filled with gutta percha eleven years before the case was radiographed on October 10, 1925, two days previous to the "Buckley-Price Debate on the retention of Pulpless Teeth"—(See Journal A.D.A., December, 1925).

Series No. 18.

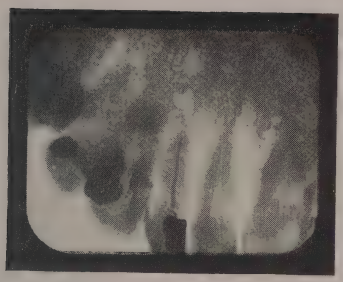

Fig. 88.

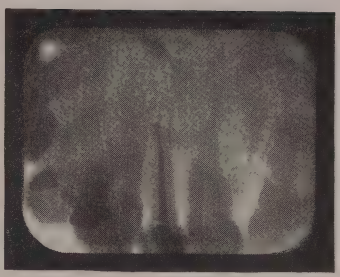

Fig. 89.

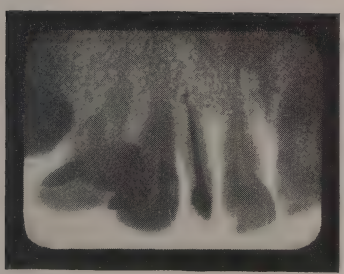

Fig. 90.

Fig. 91.

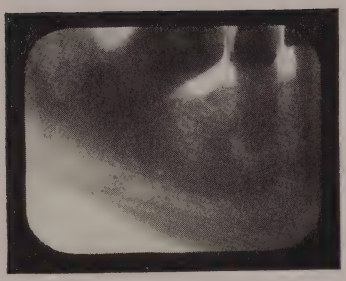

FIG. 92.

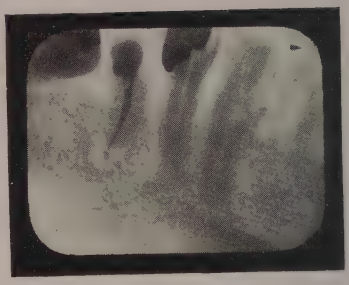

FIG. 93.

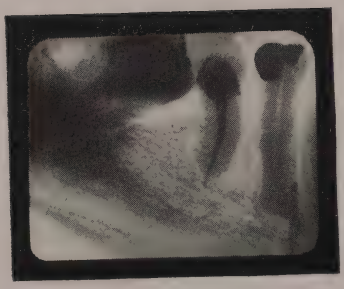

FIG. 94.

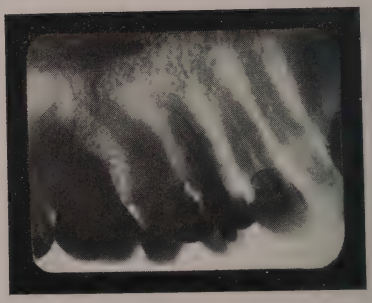

FIG. 95.

DIAGNOSIS AND TREATMENT OF NONSEPTIC PERICEMENTITIS

GENERAL CONSIDERATIONS

It is not the intention to introduce in these pages needless pathologic facts, yet in the treatment of pericementitis it is important to remember that the pericemental membrane is very vascular and well supplied with nerves; that it is enclosed within bony walls, and, therefore, when inflammation exists in the tissue the membrane becomes thickened, forcing the tooth from its socket. This elongation of the affected tooth is one of the chief symptoms of true pericementitis.

Before discussing the therapeutics of this condition, I desire to indelibly impress upon the mind of the reader the fact that this condition is too frequently produced by carelessness on the part of dentists. It is not always possible to successfully perform dental operations without irritating the susceptible pericemental membrane; however, much of the trouble can be avoided if judgment is exercised and proper precautions are taken in treating teeth.

It is essential that we differentiate between *nonseptic* and *septic* pericementitis. Both are inflammatory conditions of the pericemental membrane, the difference being due largely to the exciting agents causing the pathologic condition. Nonseptic pericementitis results largely from drug or mechanical irritants, while septic pericementitis is caused by pathogenic bacteria and other poisonous and irritating substances which have escaped from septic root-canals. Both conditions may result in suppuration; the former through cryptogenic or hematogenous infection from the circulation, the latter as the natural consequence of the progress of the disease. I shall discuss here the treatment of nonseptic pericementitis only. Those cases resulting in pus formation or alveolar abscess will be considered subsequently.

There are at least two classes of irritants by which nonseptic pericementitis is produced, viz.:

1. Drug irritants.
2. Mechanical irritants.

Drug Irritants.—There are many circumstances and conditions which influence the action of drugs upon different individuals and

upon the same individual under different conditions. We find cases occasionally where pulps have been removed by pressure anesthesia, and where, seemingly at least, every precaution was taken in sterilizing the dentin, selecting a sterile anesthetizing solution, and in applying the pressure, yet severe apical pericementitis follows. This may or may not be due to the drugs used in performing the operation. There are cases, too, where the pericemental membrane becomes highly inflamed and extremely responsive from the action of arsenic trioxid, even when the drug was properly sealed within the tooth only a short time. These are conditions over which the operator seems to have no control. I know that this is a dangerous doctrine to promulgate; for it is so easy to blame the patient for some idiosyncrasy, when the fault is ours. Drugs are often responsible for these conditions by having been injudiciously employed; yet it is only fair to state what every pharmacologist knows to be a fact that the action and effect of drugs are modified or influenced by such conditions as disease, temperament, sex, race, size, age, habit, idiosyncrasy and temperature, and the method, time of administration, preparation and dose of the drug. It has been stated elsewhere that an anodyne treatment is indicated after the mechanical or surgical removal of the pulp. Therefore, care should be taken to select drugs for this purpose which produce a soothing and not an irritating effect. There are some instances in dental practice where we desire to irritate and thereby stimulate the pericemental membrane; but this should be avoided here. Judgment should also be exercised in sealing in anodyne remedies, such as phenol, oil of cloves, etc., in the canals, especially in bicuspid and molar teeth, for should the temporary filling be left too full and the remedy forced through the apex by the closing of the jaws, even these agents cease to be anodynes and become irritants. Whether phenol, oil of cloves, and similar drugs or remedies are anodynes or irritants, depends largely, then, on where and how they are used.

In filling root-canals it is the practice of many dentists to moisten the canals with *eucalyptol* before introducing chloropercha and the gutta-percha cone. Care must be taken here to use eucalyptol and not oil of eucalyptus, unless it be the refined product. Commercial oil of eucalyptus has been the cause of many cases of apical pericementitis following the most careful filling of root-canals. The eucalyptus tree produces a volatile oil which contains three constituents, each distilling over at different temperatures; the first product thus obtained is eucalyptol, hence the most volatile constituent of oil of eucalyptus and the one which is the solvent for gutta-percha.

While eucalyptol is a slight irritant, it is not nearly so irritating as oil of eucalyptus. The irritating property of eucalyptol can be modified and its antiseptic value increased by adding menthol and thymol in the following proportions.

℞—Mentholis,	gr. ij (0.13 Gm.)
Thymolis,	gr. iij (0.18 Gm.)
Eucalyptolis,	f℥j (4.0 cc.)—M.
Sig.—Use as directed.	

This remedy is equally as good a solvent for gutta-percha as is eucalyptol alone, and will be called *eucalyptol compound* in the following pages.

Some drugs when internally administered, notably mercury and its compounds, are capable of producing nonseptic pericementitis. This has been previously mentioned under Mercurial Stomatitis.

Mechanical Irritants.—The pericemental membrane is frequently, I might add too frequently, irritated by mechanical irritants, such as root-canal fillings. There is, perhaps, more pericementitis produced by root-canal fillings than by any other mechanical irritant. In filling root-canals we should be absolutely certain that the canal is *aseptic*. If there be any doubt as to this, the operation should be deferred. The technic of filling root-canals will be discussed later.

Fig. 96.

There are many other mechanical irritants which can be mentioned as causative factors in producing pericementitis; such as ill-fitting partial plates, crowns and bridges, malleting, regulating, faulty occlusion, calcific deposits on the roots of teeth, impaction of food between teeth with faulty or no contacts, etc. (Fig. 96.) This patient presented with a case of severe pericementitis. Not having treated the tooth myself, the picture was taken to ascertain the condition of the canals of the second molar. It shows that the mesial canals were small and tortuous and not filled to the end. This might have caused the pericemental trouble; but, at the time, I

questioned it very much. You will also notice that a pulp nodule shows distinctly in the third molar. This was verified by a second radiogram. As yet the nodule is causing no trouble. The occlusion on the inlay was a little too full and there was a slight tendency toward a pyorrheal pocket on the distal, due to the tooth tipping forward owing to the loss of the first molar and the occlusion—thus opening the contact slightly. Here we had four possible causes for the pericementitis: The nodule in the third molar, the faulty contact and the resultant impaction of food between the molars, the occlusion, and the imperfectly filled root-canals of the second molar. The adjustment of the occlusion and the scaling and polishing of the exposed tooth-surface cured the case. This was done several years ago and there has been no recurrence of the trouble.

Treatment of Nonseptic Pericementitis.—The first step in the treatment of nonseptic pericementitis is to adopt the surgical principle of ascertaining the cause and removing or correcting it, if at all possible. In the earlier stages of pericemental inflammation, it is not always an easy matter to ascertain the *true cause* of the disturbance. For instance, in those cases following the removal of the pulp tissue, it is difficult to know whether the cause is the root-filling, the medicine used in the treatment, or whether we failed to establish and maintain asepsis in performing the operation. The author is inclined to believe that it is more frequently the latter than most operators are willing to admit; for certain it is that the more nearly we approach *absolute asepsis* in these operations, the less pericemental trouble we will have. The teeth thus affected are extremely sore, and any remedy can be used in the treatment that will give immediate relief. This is what the patient most desires, and, too often it appears, it is that which the dentist fails to give. Both local and general remedies can be employed. General remedies are more valuable in the treatment of septic pericementitis. If they are used at all in treating nonseptic pericementitis, they should be used only in cases where the patient is nervous and has lost considerable sleep, unless some drug, like nitroglycerin, is given to relieve the engorged capillaries. For immediate relief we must depend largely upon the local application of drugs and remedies. In those cases following the removal of the pulp by either the anesthetization or devitalization method, and where the canals have not been filled, the pain can be relieved almost instantly by the following method: Adjust the rubber dam. If it is necessary to use a clamp, it should be placed on the tooth posterior to the one affected. Sterilize the teeth included in the dam and remove the dressing from the canals.

Dehydrate the tooth-structure with modified alcohol. Then wrap cotton loosely around a smooth, sterile broach, dip in oil of cloves or eugenol, and carefully work in each canal. Remove the broach, leaving the cotton. Heat should now be applied to the remedy by means of a hot-air instrument or a chip-blower until the cotton becomes dry. Repeat this process several times, after which the same remedy should be carefully sealed within the canal. Under no condition should the cavity be left unsealed. In the above treatment, we not only get the benefit of the heat, which is valuable, but the eugenol, the constituent of cloves, is driven into the tooth-structure, producing a profound anodyne effect upon the sensitive membrane. The author has succeeded in giving immediate relief by this method of treatment when many others have failed. Grinding the cusps of the tooth where it can be done without injury is advisable; a counterirritant can be applied to the gum and the patient dismissed for several days. It is well also to prescribe two or three doses of nitroglycerin to facilitate the circulation of blood in the membrane. It is scarcely necessary to instruct the patient to favor the tooth.

In the treatment of pericementitis following the filling of the root, having every reason for believing the canals to be aseptic, one of the last things the author would suggest doing would be to attempt to remove the root-filling. Usually this only serves to further aggravate the condition. These cases can best be treated by counterirritation and general remedies. By counterirritation is meant the application of an irritant to some normal part of the body for the purpose of influencing favorably some other part, usually deep-seated, which is diseased. This irritant is generally applied to the gum over the affected tooth. Capiscum plasters, black mustard papers and cantharidal collodion are valuable; or the following liniments, which are more generally used, give much relief:

℞—Mentholis, gr. xx (1.3 Gm.)
Chloroformi, f℥jss (6.0 cc.)
Tincturæ aconiti, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Dry the gum and apply freely over the affected tooth, keeping the field dry for a few seconds.

This preparation is known as *dental liniment.*

℞—Mentholis,
Iodi (crys.), āā gr. x (0.6 Gm.)
Chloroformi, f℥jss (6.0 cc.)
Tincturæ aconiti, q. s. ad. f℥j (30.0 cc.)—M.
Sig.—Make one application to the dry gum as above.

This liniment is called *refrigerant counterirritant.*

℞—Liquoris iodi compositæ, f℥j (30.0 cc.).
Sig.—Use as above.

This is the official compound solution of iodin, known also as Lugol's solution.

Inasmuch as tincture of aconite is an important ingredient in many liniments used in the local treatment of pericementitis and facial neuralgia, it is well to remember that the United States Pharmacopeia of 1900 reduced the strength of this preparation from 35 per cent. to 10 per cent. This is also the strength of the preparation in the U. S. P. X. Therefore the new tincture can be employed more freely in these cases without danger of poisoning. However, care should be taken to see that, in applying remedies containing tincture of aconite to posterior teeth, the patient does not swallow the remedy; especially should this precaution be observed in using dental liniment.

As a remedy to be applied by the patient at home, a split raisin, soaked in hot water, and on which is dusted red pepper, can be held on the gum over the affected tooth. A very efficacious remedy is to direct hot water with some force on the part, beginning with warm water and increasing the heat gradually until it is nearly boiling. This must be kept up until we get the full benefit of the heat and resolution is promoted. Another good remedy that the patient may employ is the hot foot-bath. The value of this remedy, like the application of hot water to the gums, depends largely upon the manner in which it is applied. A deep foot-bath tub should be used and the temperature of the water gradually increased until it is as hot as can be borne. This should be continued from twenty to thirty minutes.

There are many other drugs and remedies which can be employed in the local treatment of this condition. Those which have been mentioned here the author has found valuable in his practice. It is far better to have a practical knowledge of a few remedies than a superficial knowledge of many. The general remedies to be administered in the treatment of nonseptic pericementitis, if found necessary, will be discussed subsequently under the treatment of septic pericementitis and incipient abscess, which conditions are closely related.

DIAGNOSIS AND TREATMENT OF SEPTIC PERICEMENTITIS AND ACUTE ALVEOLAR ABSCESS

GENERAL CONSIDERATIONS

The treatment of septic pericementitis and acute alveolar abscess, as was intimated under Nonseptic Pericementitis, is so nearly identical that the therapeutics will be discussed here conjointly. Suppurative pericementitis which occurs in the periapical area means an alveolar abscess, for *suppuration* implies the presence of pus. In those cases of gangrenous pulps where the patient did not present for treatment until the confined gases had escaped into the periapical tissue, carrying therein the bacteria and toxins, we will find that a practical knowledge of pathology and therapeutics will serve us well. It is in these cases that good judgment must be exercised and extreme care taken. Frequently patients delay coming to the dentist until the infection has progressed to the point where all remedies will fail in preventing suppuration; but in many instances this result may be attained by the proper use of drugs. In this connection it is well to remember that Hopkins, of Boston, a few years ago conducted a series of experiments in which he proved that not only did bacteria proliferate more rapidly in uncared-for and neglected mouths, but that their virulency was greatly enhanced. Blair states that "certain pus-producing organisms, such as the Staphylococcus and Streptococcus pyogenes, will always tend to produce pus. Often, however, owing to the lack of virulence or lack of sufficient numbers in proportion to the tissue resistance, the inflammatory process may be cut short before it reaches the stage of suppuration. Thus there may be swelling of the gum and face around an infected tooth, but this may subside without the formation of pus." To this I may add that this is especially true if the tooth receives the proper treatment.

Local Treatment.—The local treatment here differs in no particular essential from that outlined for a case of gangrene of the pulp. The tooth should be located and the pulp-chamber opened into freely, under aseptic precautions, holding the tooth in some manner so that the chisel, bur or excavator will not further aggravate the condition. Then the cavity should be sprayed or washed with an antiseptic solution, dried, in this case with alcohol, and formocresol sealed in

the pulp-chamber with cement. I know, to my regret, that this is not the general method of procedure in the handling of these cases; but I am certain that the best results will be obtained when we follow the general rule that all remedies should be sealed with cement. This will force us to correctly diagnose the condition and employ the means and remedies indicated in the rational treatment of the case. Until we are willing to spend the necessary time to accomplish this end, we are not living up to the highest ideals of our calling. Let it be remembered that as yet there is no suppuration in these cases, and any dentist who deliberately leaves the canal and cavity open to external influences, or who uses temporary stopping because it is easily removed, and instructs his patient how to remove it should the tooth continue to ache, either does not understand the condition he is treating or else he lacks confidence in his remedy. Make a correct diagnosis, use the proper remedy in the proper way and the tooth will not ache long—it matters not what the pathologic condition may be.

General Treatment.—After applying the local remedies, our attention should be given to the treatment of the infection and inflammation in the periapical area, which consists in promoting or regulating the inflammatory process. Again quoting from Blair, he says: "After an infection has once gained a foot-hold in the living tissue, we must in our treatment regard not only the infection but the inflammatory process that it has excited. We are not certain that the inflammatory process itself ever needs treatment, and we know that there are very few, if any, infections that could ever be overcome without inflammation. Inflammation is Nature's way of fighting infections, and we must work with it, not against it; for otherwise our efforts will be in vain. * * * One of the first requisites is the regulation of the body functions, especially the excretory organs. In the presence of an infection, the parenchymatous cells of various organs may become sluggish in their action and may require stimulation." In such cases the skin may be stimulated by bathing, and saline cathartics are indicated. Owing to the facility with which it can be taken and its acceptability to the stomach, the official solution of magnesium citrate is an excellent remedy to prescribe.

℞—Liquoris magnesii citratis, f℥xij (360.0 cc.).
Sig.—Take one-half at once and the other half in two (2) hours, if necessary.

Magnesium sulphate can also be given for the same purpose. With this drug the patient should be directed to take a teaspoonful

dissolved in a wineglassful of warm water, having a glass of cold drinking water at hand to drink at once after taking the strong hyperisotonic salt solution. The cold water instantly removes the bitter and unpleasant taste of the salt. Most of the large pharmaceutical houses to-day prepare "effervescent salt mixtures," of which the more important saline carthartics are constituents. These are kept by the pharmacies and come as a granulated powder which when dissolved in water makes an effervescent solution. Several that can be mentioned are: Effervescent Magnesium Citrate, Effervescent Magnesium Sulphate, Effervescent Laxative, Effervescent Seidlitz Mixture, Effervescent Sodium Phosphate—any one of which can be prescribed.

Potassium iodid in medicinal doses can frequently be administered, with beneficial results. The taste can be masked to a large degree by dissolving it in one of the official syrups. The official compound syrup of sarsaparilla and aromatic syrup of eriodictyon (yerba santa), N.F., are both good. A prescription is here given:

℞—Potassii iodidi, ℥jss (6.0 Gm.)
Syrupi sarsaparillæ comp., f℥iij (90.0 cc.)—M.
Sig.—Take a teaspoonful in water after meals.

Ordinarily, the directions would be as given, to have the patient take a teaspoonful three times a day after meals; but in these cases of septic pericementitis or incipient alveolar abscess it is best to direct the patient to take a teaspoonful every two hours until three or four doses are taken, and then follow the directions written on the label. A very good remedy to have the patient employ at home is the hot foot-bath; and unless some condition exists which is a contraindication, it is always good practice to administer nitroglycerin to deplete the capillaries in the affected, and in these cases *infected* tissues. As stated on p. 227, echafolta is a purified, assayed form of echinacea—a drug which is used extensively by eclectic medical practitioners. The author is able at this time to report favorably on the use of echafolta in all cases of infection. The dose here is from 5–30 min. (0.3–2.0 cc.) given in water every two hours, until the acute symptoms subside.

Heretofore I have prescribed and recommended, purely on an empirical basis, the salts of quinin in the treatment of infections in certain cases. I have since learned, however, that this drug interferes with the ameboid movement of the white blood corpuscles, preventing them from migrating through the capillary walls in

inflammation. The arrest of this movement lessens the phagocytic power of these scavengers; therefore, quinin is contraindicated in the treatment of periapical infections, unless we desire to lessen tissue resistance and hasten the formation of pus, when it might be given. The salt which the author prefers giving, if indicated in the conditions under consideration, is quinin bisulphate. Nearly all pharmacies have the salt of quinin bisulphate put up in the form of pills. While these pills may be given, it is much better to write a prescription for capsules. The gelatin capsule is soon dissolved in the stomach; thus we obtain the action of the drug more rapidly than when given in the dry, hard, pilular form. The following prescription can be written for the drug in two-grain doses:

℞—Quininæ bisulphatis, gr. xxiv (1.5 Gm.).
Ft. capsulæ No. xij.
Sig.—Take one capsule every hour until the effect becomes noticeable.

Quinin acts differently upon different individuals. Most adult patients know the effect of this drug upon their systems, and therefore will be able to aid the dentist in determining the amount to be taken in a given case.

One of the most prominent symptoms with which we have to contend here is pain. In most cases the pain will subside soon after the local treatment; however, it is necessary, occasionally, where the patient is nervous and has lost considerable sleep, to administer drugs which act upon the central nervous system, thereby controlling the pain. There are several drugs which, if properly given, will produce the desired effect. The formerly official compound powder of acetanilid is here recommended and can be prescribed as follows:

℞—Pulveris acetanilidi comp., gr. xij (0.8 Gm.).
Ft. chartulæ No. ij.
Sig.—Take one powder at once and the other in two (2) hours, if not relieved.

Another very useful prescription for acetanilid is one suggested by Harlan. It follows:

℞—Acetanilidi, gr. viij (0.5 Gm.)
Syrupi, f℥ss (15.0 cc.)
Spiritus frumenti, q. s. ad. f℥iij (90.0 cc.)—M.
Sig.—Take one-half at once and the remainder in two (2) hours, if not relieved.

Keefe, of Chicago, suggests using dilute alcohol by which instantaneous and often permanent relief can be obtained in those cases where the tooth involved is one of the six upper anterior teeth. A prescription for the remedy is here given:

℞—Alcoholis,
Aquæ, āā f℥j (30.0 cc.)—M.
Sig.—Use as directed.

This remedy is best administered in the form of a spray, using a watch-case atomizer for liquids, forcing the spray well back into the nostril on whichever side the affected tooth is located. The application can be repeated as often as is necessary, without any ill effects. In case an atomizer of any kind is not at hand, about fifteen minims (1.0 cc.) of the remedy can be placed far back in the nostril with a suitable syringe.

The author does not wish to be understood as suggesting these various internal remedies in all cases of acute abscess. No therapeutist can tell exactly what internal drugs he would suggest without seeing the case and knowing the history; for there are many circumstances and conditions which modify the effect of drugs. Every remedy here mentioned, however, will be found useful in certain cases.

The Question of Extraction.—The question of extraction in acute alveolar abscess is a disputed one. Many writers recommend extraction as a speedy means of affording relief (see Fig. 97).

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FIG. 98.—This shows a sequestrum which was exfoliated from the lower jaw. This result followed extensive infection, endangering the life of the patient, and ultimate necrosis from the extraction of a lower second bicuspid root during the acute stage of an alveolar abscess. A mixed infection doubtless resulted from the laceration of tissues. It will be noticed that the sequestrum contains the mental foramen, which means, of course, that the mandibular nerve, artery, and vein were severed. The lip on the affected side was partially paralyzed for a period of two or three years; and, in opening into the first bicuspid for the purpose of pulp removal for bridge-work, six months later, the pulp was dead and just beginning to undergo the process of decomposition. I rather suspected a specific history, but was unable to confirm the suspicion.

Unfortunately, however, this is not always the solution of the problem; for if there be much osteomyelitis and the roots of the offending tooth be firmly embedded, it is a rather dangerous procedure to extract during the developmental stage, on account of the liability of a mixed infection, resulting oftentimes in necrosis and

frequently even threatening the life of the patient (see Fig. 98). If the root be a worthless one and easily extracted, its removal would doubtless afford free drainage for the abscess. There is no set rule governing extraction in these cases. The operator must be guided largely by the conditions as found. When extraction is resorted to, antiseptic mouth-washes should be prescribed and the case watched closely for a few days until we are certain that no complication will follow.

CHRONIC ALVEOLAR ABSCESS

GENERAL CONSIDERATIONS

There are two types of chronic infection in the mouth—alveolar abscess and periodontoclasia (pyorrhea alveolaris); and there are also two varieties of chronic alveolar abscesses—those without an external opening except, perhaps, through a cavity in the offending tooth, and those which are discharging through a sinus. In these cases the decomposition of the pulp tissue is complete; the intermediate products (ptomains and amido-acids) have largely been broken up, and pus has been formed from the tissue and fluids surrounding the ends of the roots. Wherever it is possible, a radiogram of the affected tooth and periapical area should be obtained; for upon the radiographic findings to a large degree will our decision depend as to whether the case should be treated medicinally, surgically, or both. In the past many teeth with chronic alveolar abscess associated therewith have been retained in the mouth, in utter disregard of the possible deleterious effects they might have on the general health of the patient. This will not be the practice of dentists in the future; though it may safely be said that, at the present time, many teeth are being sacrificed which, under proper treatment, might be saved without menacing or jeopardizing the patient's health. Good judgment should be exercised here and our decision as to the best method to follow, under the conditions, should be governed by several factors—the amount and character of the periapical involvement; the length of time the abscess has been standing; the condition of the patients health, whether there is a systemic disease which may have a direct or immediate relation to the local condition; and all other factors relating to the case at hand.

It should be remembered at all times that the comfort of the tooth is no index as to the safety of its retention. Many of these chronic infections give little or no discomfort. With periapical infections, this may be the source of the greatest danger, due to the absence of local reaction. In an effort to solve the problem, this question arises: Is the danger proportional to the evidence of absorption of bone about the apex of a suspected tooth? Price,[1] after a study of the conditions, concludes as follows: "Since different people react

[1] Dental Infection—Oral and Systemic. Vol. I, p. 176.

differently through a wide range to a given infection, the quantity of the absorption is not a measure of the danger; but, on the contrary, it may be, and frequently is, true that the patient suffering severely from a systemic reaction caused by a dental infection, shows very little absorption compared with that which the same dental infection would produce in a patient with ample and high resistance."

In all cases of dental infections, wherever located and however disclosed, we should study carefully the subject of natural and acquired immunity and understand more fully the biologic properties of the tissues and fluids of the body; the production of antibodies, Nature's method of controlling and eradicating disease. A decision for or against the retention of pulpless teeth in the mouth should not be made in any case until after we have questioned and studied the individual patient. The condition of the patient should be the deciding factor. If normal resistance is lacking as evidenced by grave constitutional disorders, it would certainly be a mistake to advise the patient to continue with the overload when it could be reduced or perhaps entirely corrected by the judicious extraction of certain infected teeth. But where normal resistance is evidenced by the absence of systemic involvement so far as is known or can quite readily be determined without unduly frightening the patient, we have an entirely different story. This is what the author has in mind when he takes the position that practically all recently infected pulpless teeth, with or without bone involvement, can be treated and saved without jeopardizing the health of the average patient in any way. The great majority of patients presenting with evident foci of infection in the mouth are not systemically involved. This is what is meant by the "average patient."

I. ABSCESS WITHOUT SINUS

In treating that variety of alveolar abscess which is without an external opening, our method of procedure is somewhat different from that of an acute abscess. The tooth should be located; the rubber dam adjusted, and the teeth sterilized as before; then the pulp chamber is opened with a suitable round bur.

Disposing of the Pus.—Usually the pus flows freely, in which case it is permitted to do so, pressure being made on the tissue immediately over the end of the root. It should be our effort to mechanically evacuate as much pus at each sitting as is possible; for it is far better to remove pus in this manner, when it can be done, than to depend upon some chemic agent to destroy it, or upon Nature to dispose of it.

THERAPEUTICS

The formocresol remedy will be useful here. The canals should be dried with alcohol as thoroughly as possible and the remedy on cotton hermetically sealed in each canal. It is, however, at this sitting, impossible to get the canals dry, and it is unnecessary to have them so, for the remedy will penetrate where moisture is present. This is an advantage over most remedies suggested for this purpose. In those cases where there is pain and swelling, together with a copious flow of pus which seemingly cannot be checked at this time, it may be necessary to evacuate the pus as completely as possible, loosely place in the canal a few shreds of cotton saturated with an antiseptic remedy (phenol compound), and then place in the cavity a pledget of cotton dipped in liquid petroleum. In no case should the cavity be left entirely open; and the author desires to emphasize that it is seldom necessary to resort to this temporary expedient, if the proper time is spent in opening into the tooth and evacuating the pus. The dressing, in any event, should be changed every day until it can be removed without the pus flowing from the canals. When pus is forming rapidly at the ends of the roots, the dressing soon becomes dissipated, the remedy loses its effect, and it is a loss of time to leave it in the canals more than twenty-four hours. Unless there be some complication, the pus formation should be checked in one or two treatments, at which time phenolsulphonic acid can be used in the same manner as in the treatment of gangrenous pulps, and eucalyptol compound sealed in the canal with the double sealing material as elsewhere explained. It is now possible to change the dressings too often, however. The formation of pus has been checked, and the tooth should not be disturbed for at least one week or ten days, in order to give Nature a chance to effect a cure. If, at the end of this time, there is no evidence of pus and the case gives a favorable history, the canals can be filled. Should there, however, be a slight odor, although the tooth has not caused any trouble, we are not justified in filling the root. In these cases we may suspect a root-end involvement, or some other complication, when the radiogram is invaluable. Formocresol may be used again as in the initial treatment; but it should be remembered that the value of formaldehyd in any remedy to be used in the treatment of these conditions depends upon the power this agent has of uniting chemically with hydrogen sulphid, ammonia and poisonous ptomains. When these substances are not present, formaldehyd should be used with care and judgment. This precaution is mentioned here because formaldehyd is an irritating gas, and the amount of any remedy containing it should be in accordance with the conditions as found.

Weeping of Serum.—Quite frequently in these alveolar abscess cases, after the formation of pus has been checked, we have a weeping of serum from the canals. An excellent remedy to use in this case is eucalyptol to which thymol has been added in the following proportion:

℞—Thymolis, gr. x (0.6 Gm.)
Eucalyptolis, f℥j (4.0 cc.)—M.
Sig.—Dry the canal as thoroughly as possible and hermetically seal in the remedy.

If this remedy fails to check the secretion and the fluid is serum, not pus, no hesitancy need be felt as to filling the root, although the canals cannot be dried. The condition should not be confused with a cyst, which quite frequently occurs in the apical area of teeth. (See Figs. 67–70; Series No. 10, page 424.) Brophy defines a cyst as a sac containing fluid, or a semi-fluid substance, which may be gelatinous or inspissated. A cyst may contain mucus, saliva, bile, urine, etc., depending upon the organ with which it is associated. It should not be difficult to differentiate *cystic fluid* from *normal serum* which also frequently fills a cavity formed by an abscess. In fact the serum contains the elements with which Nature rebuilds the lost tissue. If a cyst is suspected the diagnosis should be confirmed. The treatment of a cyst is surgical, for which the reader is referred to works on Oral Surgery.

Complications.—Occasionally we find a chronic alveolar abscess of this variety where it is almost impossible to check the formation of pus by applying drugs to the canals of the teeth. In those cases where the pus continues to flow freely when the dressing is removed at the third or fourth sitting, some complication can be expected. It is the safest practice in all such cases to extract the tooth. However, if for any exceptional reason treatment is undertaken, then it is necessary to force some stimulating agent through the apices of the roots, after the pus has been mechanically evacuated. The stimulating agent which the author uses almost invariably is phenolsulphonic acid. In resorting to this means of bringing about a more acute condition, I desire to emphasize the necessity of first evacuating the pus as completely as possible before using the remedy, after which the agent should be placed in the canal on cotton and gently forced through the apices, then neutralizing that which remains with a solution of sodium bicarbonate, desiccating the canal with alcohol and hermetically sealing therein an antiseptic like phenol compound or eucalyptol compound. It will be found that one or two treatments will usually check the formation of pus, after which the

case can be treated as an ordinary abscess of this kind. In case this method fails to effect a cure, however, it will be necessary to establish surgically an opening through the overlying process and soft tissue and treat as for an ordinary discharging abscess—which treatment will be considered later.

Hypertrophied Alveolar Process.—This condition is quite frequently associated with abscesses without a sinus, or a low grade chronic inflammation of the alveolar process due to septic foci at the root-ends of pulpless teeth. It is the safest practice to extract teeth which have caused hypertrophy of the alveolar process. Even the aseptic treatment and filling of the canals of the affected teeth will not reduce, in many cases, the hypertrophied process, and to permit it to remain might lead to an osteoma or an osetosarcoma (Marshall). In such cases judicious curettage should accompany or follow the tooth removal.

II. ABSCESS WITH SINUS

In those cases where the pus is discharging into the mouth through a sinus, our first duty is to locate the offending tooth. This is generally a simple matter for the reason that the sinus usually opens immediately over the tooth from which it comes. The pus in making its exit, however, follows the line of least resistance, and in some cases the condition of the process is such that the pus burrows forward or backward, and opens through the gum at a point several teeth removed from the one which is causing the trouble. (Fig. 99.) These are the cases that are difficult to diagnose, especially when the abscess has been discharging for some time, when there is not much tenderness in any special tooth, and when there are several pulpless teeth on this side of the mouth. Sometimes two or more teeth containing gangrenous pulps have a common sinus (see Fig. 109 and Figs. 127 and 128). In this case it would be impossible to heal the tract by treating only one of the teeth. The use of a silver probe will be valuable in all such cases. By gently working the probe forward or backward the sinus can be explored and the offending tooth or teeth located without drilling into innocent teeth—a discouraging procedure to both patient and dentist. In all such cases the radiogram is an invaluable aid in diagnosis.

THERAPEUTICS

The tooth being located, all that is necessary to effect a cure—there being no complication—is to clean the canal with acids or

alkalies, preferably the former, and then force some bland solution through the root-canal and sinus, thus being certain it is well established; cauterize the tract with phenolsulphonic acid, or other stimulating cauterant, hermetically seal in the canal or canals an antiseptic, like phenol compound or eucalyptol compound, and, at the subsequent sitting, the case giving a favorable history, fill the root.

Establishing Sinus and Disposing of Pus.—If the abscess is not discharging, and in those cases where it is discharging, it is well before adjusting the rubber dam to enlarge the mouth of the sinus with a lancet or bistoury. By dipping the lancet in phenol, this may be accomplished with very little pain to the patient. After this is done, the rubber dam should be adjusted and the canals freely exposed. Now that the infection is past the end of the root, we need not hesitate to clean the canal at this sitting by chemico-mechanical means. The canals being clean, we are ready to establish the sinus. To do this we need a bland solution and a good hypodermic syringe with a long straight needle for anterior and a long curved needle for posterior teeth. There is an advantage in having a long needle, for the nearer the point is to the apex of the root, the less packing and force are required to send the solution through the sinus. Any bland solution can be used for this purpose. The author suggests physiologic saline solution or peppermint water to which 2 min. (0.12 cc.) of phenol have been added to the fluidounce (30.0 cc.). A piece of unvulcanized rubber of the proper size should be selected, softened in the flame, and a hole made in the center through which the needle is placed and inserted into the canal. The rubber should now be tightly packed around the needle and held on either side with flat-nose pliers, when pressure can be made on the piston of the syringe and the solution forced through the sinus. This should be repeated several times, care being taken not to break the needle in the canal. If convenient, one corner of the dam can be raised, exposing the mouth of the sinus to view. There are two objects in forcing a bland solution through the sinus: one is to be certain that it is open, and the other is to mechanically wash out the pus. Whenever pus can be mechanically removed, it is always better to dispose of it by this means rather than to do so by the use of some chemic agent. In former years, it has been a common practice, after establishing the sinus, to use a solution of hydrogen dioxid. This is often a dangerous procedure and *always unnecessary* if the first solution has been used in sufficient quantity.

Cauterizing Sinus.—For cauterizing the sinus in simple cases 95 per cent. phenol has been largely employed. An excellent prepa-

ration to use for this purpose is the phenolsulphonic acid. With the sinus well established, it is never necessary to place either of these solutions in a hypodermic syringe. The author knows of several instances where this has been tried with disastrous results. The remedy can be applied to the canals on cotton, when, with unvulcanized rubber and a suitable instrument, it can be forced through the sinus. Alcohol is a positive antidote for phenol poisoning; it is a solvent for phenol. If this agent is used, the alcohol bottle should, therefore, be in a convenient place so that the effect of the remedy used in the canal can be neutralized at once when it appears at the mouth of the sinus. Phenolsulphonic acid may be neutralized in this case with alcohol followed with a solution of sodium bicarbonate. If this has been well done, it matters little what drug or remedy is sealed in the canal. The phenol compound or eucalyptol compound remedy will give excellent results if hermetically sealed in the canals for about one week, always using the double sealing process. Phenolsulphonic acid, as made when its employment in dental therapeutics was first suggested by Cook and MacWhinney, contained an excess (15 per cent.) of uncombined sulphuric acid, which rapidly disintegrated cotton; therefore, it was necessary to place it in the canal on threads of asbestos, wool fiber, or silk, and force it through the sinus in the usual manner, cauterizing the tract, and also stimulating the sluggish cells in the area to healthy activity. It is now possible to procure phenolsulphonic acid with less than 1 per cent. of free sulphuric acid (see p. 110). This product can be used with cotton.

Wherever *drainage* exists, a 5 per cent. solution of dichloramin-T may be forced through the sinus and permitted to come in contact with all infected tissue. This is an excellent remedy to employ here and should be used in an all-glass syringe with a gold or platinum needle. In this relation it should be remembered that water causes rapid decomposition of dichloramin-T, with evolution of hydrochloric acid. This agent, therefore, should never be permitted to escape (only in the smallest droplet) through the end of a root in the treatment of any periapical infection; except in those cases under consideration where *free drainage* is afforded.

In cases of long standing when we can reasonably suspect a roughening of the end of the root or process through which the pus has been discharging, it is best to remove the teeth at once and curette the area involved (see Fig. 100). It is sometimes difficult to establish the sinus, especially on molar teeth. In all such cases, if there is no

complication, the treatment can be that outlined under Treatment of Abscess Without Sinus.

The author does not believe in delaying the root-filling long after the sinus has been cauterized in uncomplicated cases; for by filling the root as soon as we are certain that the sinus is healing, we avoid a weeping condition, which usually exists and which is annoying when this part of the treatment is delayed for one month or six weeks as advocated by some writers. In these cases where the first treatment has been thorough, and the case gives a favorable history, the root should be filled at the second or, at latest, the third sitting. If the

FIG. 100.—This radiogram illustrates an interesting case, which was not treated by the author and the history is, therefore, negative. The radiogram shows that the canal is not properly filled, while the root carries a well-adjusted porcelain crown. It is futile to attempt to cure an abscess under such conditions by simply injecting such an agent as bismuth paste through the sinus into the affected area. Had the radiogram shown that the canal was properly filled external curettement would have been the proper treatment. In fact, had the canal been properly filled, the abscess, in all probability, would not have developed. In the light of our present knowledge today, such teeth as these should be extracted.

case does not yield to the above treatment, some complication may be suspected, when the tooth had better be extracted.

COMPLICATIONS

There are several complications of chronic alveolar abscess of both varieties, with and without a sinus, where it is necessary to modify or change the general method of treatment to meet the conditions as they exist, if, indeed, it is wise to undertake treatment at all. For instance, in the case of an abscess without a sinus where we can reasonably suspect, and where the indications point to, a roughening of the end of the root, we ought not to expect to cure the case by simply sealing remedies within the canals of the tooth. If we do, we are expecting too much of drugs. Again, in a case of abscess with a sinus where the pus has been discharging for

several months, with the not unusual result that the end of the root or process through which the pus has discharged has become roughened, we should not expect to effect a cure by forcing phenol or the phenol compound through the sinus, because such agents as these have no action whatever on the bony structures. The author desires to emphasize again the value of the radiogram in determining the extent of involvement and the nature of the complication. It is seldom a positive means of diagnosis, but it is a material aid (see Figs. 101 and 102, also Fig. 105).

FIG. 101.

FIG. 102.

FIG. 101.—This radiogram shows an abscess with extensive resorption of alveolar process between the central and lateral roots, both of which had been previously filled and carried jacket crowns. The radiogram shows the lateral root perfectly filled and the abscess caused by the imperfectly filled central. These cases are often difficult to diagnose.

FIG. 102.—This radiogram shows a similar case to that illustrated in Fig. 101. It was difficult to determine whether the abscess came from the central or lateral root. The radiogram shows the lateral root over-filled, but the abscess coming from the central.

1. Denuded End of Root.—One complication we may expect to find in abscesses of long standing, especially in the variety without a sinus, is where a large area of tissue in the periapical area has been resorbed or broken down, leaving the end of the root projecting into the absorbed area (see Fig. 103). It is possible, in these cases, to make pressure over the end of the root and mechanically evacuate all of the pus above the apices; but we cannot expect by this means to evacuate the pus below and surrounding the end of the root projecting into the space. In this case we must do one of two things: Force some stimulating agent through the end of the root into the infected area, to create a more acute condition; or surgically establish a sinus through the overlying process and soft tissue, and treat as an ordinary discharging abscess. While the author does not hesitate to adopt the latter method if necessary to effect a cure, it will

be found that the use of a stimulating agent will generally suffice in these cases. It is, of course, understood that the pericemental membrane is not destroyed—a condition which the radiogram does not reveal. The agents recommended are phenolsulphonic acid or a 15 per cent. solution of trichloracetic acid. In using either of these solutions, the pus should first be evacuated as much as is possible; then the solution selected can be placed in the canal and gently

FIG. 103.—This radiogram shows a typical abscess without a sinus which developed from an imperfectly filled root of a lateral incisor.

forced through the apices, and an antiseptic sealed in the canal. One or two treatments will usually be sufficient to check the pus formation, when the case can be treated in the ordinary manner. If, however, this does not effect a cure, it is a waste of time to prolong such treatment, and recourse should be made to surgical methods, which will be discussed later.

FIG. 104.—This shows an upper second bicuspid exfoliated by Nature with the entire surrounding alveolar process attached. This result followed a slight traumatic injury to the part, shortly after the pulp had been removed by pressure anesthesia. The first bicuspid ultimately became so loose that its removal was necessary. The author was able to elicit a previous history of syphilis, the disease having been cured a number of years before.

2. Resorbed or Roughened End of Root.—Another complication of both varieties of chronic alveolar abscess is where the pus has been in contact with the end of the root sufficiently long to cause resorption, leaving a roughened end which irritates the tissue

and prevents healing. Sometimes, also, the process through which the pus has burrowed is left with sharp edges. In all such complications, surgical treatment is especially indicated. These cases generally yield nicely to the removal of the denuded and roughened root-end, and the thorough curettement of the affected area.

3. Encystment of Root.—A difficult complication to treat is an abscess which forms on a root, the end of which has become encysted from deposits, excementosis or other causes. In order to effect a cure in these cases, it is necessary to establish a sinus and remove the deposits, excise the root-end, or extract the tooth. The method of excising the root-end will be discussed later.

4. Involving Bone.—Every acute and chronic alveolar abscess invites bone complication. There is an osteomylitis; the tissues are infected by the invading organisms; and during the progress of the abscess these structures are broken down into pus. If extraction is resorted to and laceration of the soft tissue and alveolar margins results, a mixed infection is liable to follow, as has been previously stated. The germs are highly virulent, and among them are frequently found the diplococcus pneumoniæ and the tubercular bacillus, as well as the streptococcus viridans.

In these cases it is necessary to see the patient frequently, washing the part with warm antiseptic solutions and covering the entire exposed process with the euroform paste or other stimulating remedies. The orthoform will control the pain and the iodin liberated from the europhen will stimulate and disinfect the part. If gauze is used in applying the paste, it should be changed frequently; for, if left long, it invites further infection, even when saturated at first with the oleaginous paste. After the pain subsides bismuth paste was formerly suggested to be freely injected every few days. In employing the latter remedy, however, care should be taken to prevent the wound from healing over the paste. The author has observed several cases where the part had to be reopened after several months and the bismuth paste removed, since it is not absorbed, as was supposed at first. The use here of analgentum is now highly recommended.

5. Extensive Caries or Necrosis.—Bone infection from alveolar abscesses often results in either caries or necrosis of bone. Pus is formed from the breaking down of the tissues and fluids, and, in case of caries, escapes through several sinuses (see Fig. 106). The porous dead bone may be detected by a pointed steel probe. In necrosis the parts involved die *en masse*, and the sequestra are finally loosened and gradually work out as one large or several small pieces. In cases

with a syphilitic history, even if the case has long been considered cured, there is a great tendency toward necrosis (see Fig. 104). The

FIG. 106.—This radiogram shows bismuth paste which was injected into an abscess pocket. Extensive caries of bone resulted from a dead pulp in the cuspid tooth. An opening was made both labially and lingually, the part curetted and packed with euroform gauze. The second day after operation the bismuth paste was injected, and the radiogram taken. It did not absorb and was subsequently removed.

treatment here is largely surgical. The dead bone must be removed, after which the parts should be kept clean and stimulated until

FIG. 107.

FIG. 108.

FIG. 107.—This radiogram shows a large abscess cavity under the floor of the nasal and antral cavities, the result of the death and decomposition of the pulp in the lateral incisor. The dark spot shows the outline of the cavity which had been injected with bismuth paste from a lingual opening. To cure the case it was necessary to open from the labial, excise the lateral root and thoroughly curette the affected bone. After the operation the case was first packed for 24 hours with euroform gauze to control the pain, followed with the injection of bismuth paste until granulation filled the cavity.

FIG. 108.—This radiogram shows the case, illustrated in Fig. 107, immediately after the surgical operation. In excising the root, the end dropped into the deep lingual pocket where it was difficult to find and remove (see *a*). The radiogram aided materially, as it verified the presence of the root-end and its location.

healed. It is generally best in cases of necrosis to wait for Nature to separate the dead from the living bone. A 50 per cent. solution

of phenolsulphonic acid hastens the formation of the sequestrum; after the dead bone is removed analgentum should be injected until the part heals.

6. Involving Vault.—Still another complication often difficult to cure is where the pus has worked its way through the lingual plate of bone and involves the vault of the mouth (see Figs. 107 and 108). The dense fibrous tissue covering the vault is very tough, and the pus often separates the periosteum from a considerable area of bone before ultimately discharging into the mouth. Generally a lancet is required to evacuate the pus. The involved teeth in all such cases should be extracted as well as the area curetted.

7. Secondary Abscess Pocket.—Occasionally we find an abscess of the discharging variety which does not yield to our general treat-

FIG. 109.—This radiogram shows the involvement of the upper left central and lateral incisors, with a common sinus. Both teeth carried perfectly-adjusted porcelain crowns. The radiogram not only shows the involvement of both teeth, but also shows that the roots are properly filled. The treatment here is purely surgical and means the curettement of the affected area.

ment, yet we are reasonably certain that none of the complications so far mentioned are present. In these cases we can suspect a *secondary abscess pocket.* This is especially true where the sinus opened into the mouth several teeth removed from the affected tooth. This pocket can usually be discovered by the aid of a small silver probe. The treatment is simple—all that is necessary is to open the pocket, wash it out first with a bland solution, then inject phenolsulphonic acid. In using phenolsulphonic acid in such cases it cannot be injected through the tooth, therefore it is necessary to use a syringe—a glass syringe with an asbestos-packed or glass plunger and a gold or a platinum needle.

8. Involving Two or More Teeth.—It is not an uncommon thing to find two or more teeth involved with a common sinus.

Such a case is illustrated in Fig. 109. This figure also shows the importance of radiography in the diagnosis of these complicated abscess conditions. Here it would be impossible to cure the disease by simply treating either one of the affected teeth. In this particular case, the root-canal of both teeth having been properly filled, external curettement is the treatment indicated.

9. Involving Antrum.—The pus in making its exit follows the line of least resistance, and sometimes it is easier to work its way through the floor of the antrum than through the labial or lingual plate of bone. The treatment of this complication is of sufficient importance to merit discussion by itself, and will be considered later; but in this connection it is well to remember that so good an authority as Kyle, viewing the question from the nasal side, finds that fully 50 per cent. of antral diseases are of dental origin. Many dentists believe that a still larger percentage of infections of the maxillary sinus are primary in or around the teeth in the immediate location. However, such careful and experienced observers as Cryer, Logan, Turner and others, believe that not more than 20 to 30 per cent. are primarily in the mouth. Hajek, a continental writer, sets the figure as low as 8 per cent.

Periapical Cysts.—Cysts are quite frequently associated with pulpless teeth in which are abscesses which have passed through the acute stage. Logan was, perhaps, one of the first to direct attention to the presence of cysts in connection with pulpless teeth. Surgery is the treatment indicated. The area involved must be thoroughly curetted and the part packed until granulation fills the space.

SURGICAL TREATMENT OF CHRONIC ALVEOLAR ABSCESSES AND THEIR SEQUELÆ

In all complicated abscesses which do not yield to medicinal treatment as outlined in the preceding pages, we can often save the affected tooth and make it healthy and useful by adopting surgical methods. Thorough curettement of the area involved and, if necessary, excision of the root-end will save many teeth, such as have been too frequently lost in the past by extraction. Many dentists have preferred to extract the tooth in these complicated cases rather than undertake to effect a cure by means of surgery. It is because of this fact, and with the hope of stimulating a greater interest in this phase of the subject, that the author includes herein a description of his method of treating these cases.

Indications for Surgery.—Surgical treatment is indicated in those cases where medicinal treatment has failed to effect a cure,

or where the root-canal has been thoroughly filled and the abscess develops subsequently. Especially is surgery indicated in this latter class of cases, if the affected tooth-root is firm in the jaw and has a good natural crown or carries a well-adjusted artificial crown. It is always best, to have a radiogram taken to aid in determining the area involved and whether or not the root-canal has been properly filled.

In those cases of failure to cure by treatment through the canal, and where surgery is to be undertaken, the author advises filling the canal, using gutta-percha or lead (See Series Nos. 13, 14, 15 and 16. beginning on p. 426) for the purpose, before operating, especially if the root-end is to be excised; for, while it can be done, it is rather difficult to close the generally large apical opening of the root after excision.

This operation should be done under the most aseptic conditions; the hands of the operator and assistant, the site of operation, as well as all instruments used should be sterilized; and, a thorough exploration should be made before operating so that the amount of process and root involved may be noted. The instruments used here were selected for the purpose from the surgical supply houses, and some of them have been modified by the author to better meet our demands. They are all-metal instruments and can be sterilized by boiling.

The Anesthetic.—The success of the operation will depend entirely upon the thoroughness with which it is done. It is, therefore, highly essential that the patient be assured that the operation not only can but *will* be performed with *very little pain*. This will be interesting to the patient and will increase confidence in the operator. It is unnecessary to administer a general anesthetic, as the area can be completely anesthetized by the proper use of local anesthetics. Either infiltration or conduction anesthesia may be employed, as the operator deems best. The author generally uses the infiltration method. With a strong all-metal syringe, the healthy tissue on either side of the abscess area is infiltrated with the solution, two injections being made on the labial or buccal and one on the lingual, if the abscess is discharging labially, and the reverse if discharging lingually. If pressure is made over the point of the needle with the forefinger of the left hand as the solution is being injected, only a small amount of the solution will be necessary to thoroughly anesthetize the part. It is essential that the area be completely anesthetized; for we have assured our patient that there would be practically no pain, and if this assurance is carried out, we are more likely to do our work so thoroughly that there will be no question as to the

ultimate success of the operation. It is but natural that most operators should do their work more thoroughly when the factor of pain is eliminated. The author desires to speak plainly on this point; for it will be far better for all concerned not to undertake the operation than to fail to do it with that degree of thoroughness which means success.

FIG. 110.

The Incision and Control of Hemorrhage.—When the part is anesthetized and only one tooth is involved, a vertical incision is made about one-half or three-quarters of an inch in length, directly over the affected root. In case two teeth are involved, it is necessary to make a circular incision. A bistoury, such as is illustrated in Fig. 110, is used, and care should be taken to make the incision as high as

FIG. 111.

possible (if the case is an upper tooth), stopping it about on a line with the floor of the necrotic area. If the incision is made any lower than this, the healthy process is likely to be left exposed, when it is more difficult for the tissues to close over this part. After the incision is made, and sponged to check the primary hemorrhage, a flat bone chisel (Fig. 111), used as a periosteotome, is employed to

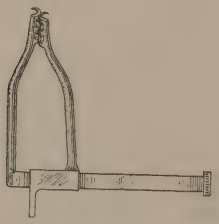

FIG. 112.

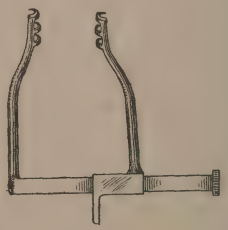

FIG. 112*a*.

separate the periosteum from the bone for about one-fourth inch on either side of the incision. The part is again sponged and a tissue retractor (Fig. 112) is firmly adjusted (see also Figs. 113 and 114). The arms of the retractor can be spread so that the soft tissues overlying the bone can be held back, and at the same time the pressure produced controls the hemorrhage from this source. There is a great

difference in the resiliency of the soft tissues, and with some patients the resiliency is soon overcome by the pressure of the retractor, in which case the retractor will loosen. To overcome the difficulty in such cases, the author has had made a spring retractor which may be used. The retractor here illustrated has also been improved with a screw arrangement attached to the movable arm, which permits tightening, if necessary, from time to time. The operation from now on should be practically bloodless; especially is this true if adrenalin chlorid is added to the local anesthetic, as should always be done. One minim (0.06 cc.) of a 1–1,000 adrenalin chlorid solution added to

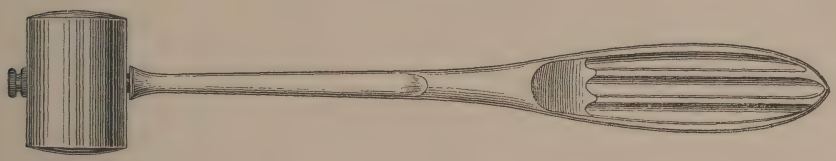

Fig. 115.

30 min. (2.0 cc.) of the local anesthetic solution is about the right proportion. The author's local anesthetic No. 2 is an excellent preparation to use in all such operations.

Exposing the Area Involved.—We now have the alveolar process over the root-end exposed to view, unless this has been destroyed by the necrotic process, which is frequently the case. Where it has not been destroyed, it is removed by means of bone chisels and mallet. The latter is shown in Fig. 115. The use of chisels and mallet was suggested to the author by Shamberg, of New York. The flat chisel

Fig. 116.

is used across the lower part of the opening and along either side, by the claws of the retractor. To chisel across the upper part of the opening, a half-round chisel is used (Fig. 116). Many patients do not like the malleting process of removing bone. While it is not necessarily painful, if the part has been thoroughly anesthetized, nevertheless it is not pleasant. To overcome this feature, the author has had heavier chisels and curettes made by means of which the bone may be removed by hand pressure. The loosened bone is then removed when the root-end and area involved should be exposed to view. We are now able to make an ocular examination

and determine whether the case simply needs curettement or whether the root-end should also be excised. If the necrotic area extends below the apex of the root, it is always best to excise as much of the latter as is involved, to make sure that healthy bone is reached on either side. It makes no difference whether the end of the root is left flat, round, or slanting, as long as healthy bone is reached.

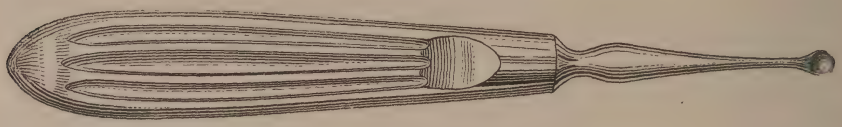

FIG. 117.

Before excising the end, it is best to drill on either side with a fissure bur. If this is done, the root-end, after excision, can be easily removed with an ordinary pair of pliers. The exposed end can now be excised with sharp fissure or cross-cut burs. Several such burs should be in readiness as they soon clog in a wet field. The operation of excising the root-ends of teeth is known as *apicoectomy* or *apextomy;* the former is the correct term to use.

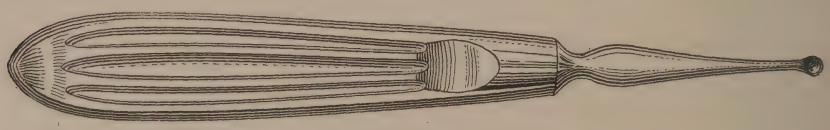

FIG. 118

Curetting the Area.—After removing the excised root-end, which as stated above is an easy matter, the remaining end of root should be made smooth, using a large round bur or stone for the purpose. The affected area is now thoroughly curetted, removing any carious or necrosed bone. Here bone curettes of varying sizes (Figs. 117,118 and 119) are employed. This is the only part of the entire operation

FIG. 119.

which may be at all painful, and the patient should now be so informed. Even here the curettage can be done with very little pain, if the anesthetic has been injected lingually as mentioned, or under conduction anesthesia there should be no pain at all.

Filling End of Root.—The process of filling the end of the root with amalgam has been suggested by Lucas, Henshaw, and others. Copper cement has also been suggested for the purpose. The author

has followed these suggestions in a few instances with seemingly good results; but he is of the opinion that a good sterile gutta-percha root-filling, recently inserted, will prove more compatible with the tissues. If it is known in advance of the root filling that apicoectomy is to be performed, it is best to fill the canal with lead. It is the safest practice, therefore, always to retreat and refill the canals of such teeth previous to performing the surgical operation. Even though the radiogram indicates that the canal has been filled to the end, in these long-standing cases we have no assurance that the root-filling was inserted under aseptic conditions or that the canal is sterile.

Washing and Packing the Wound.—With the end of the root smooth and cut down to healthy process on either side, the area thoroughly curetted, the wound should now be washed with a warm antiseptic solution. This may be done without removing the retractor. Following the washing process, the moisture should be absorbed and the wound packed with sterile gauze, saturated with euroform paste. The orthoform in this paste will absolutely control the pain which nearly always follows the use of local anesthetics and the cutting of bone, while the europhen, giving off iodin, will stimulate the cells and hasten granulation; the oleoaginous vehicle (liquid petroleum) keeps the saliva, laden with bacteria, out of the wound.

Subsequent Treatment.—The patient should be instructed to keep the mouth as clean as possible by using an antiseptic mouth-wash; and after the initial packing, which should be left only twenty-four hours, analgentum is injected every few days until granulation fills the cavity with healthy tissue. To those who have been using euroform paste in their surgical cases, the use of analgentum will naturally suggest itself. It is not intended to take the place of euroform paste in those cases of infected wounds of the jaws wherein *pain* is a prominent therapeutic factor. But in all surgical cases involving bone wherein it is essential to the healing process that the part be protected from the fluids of the mouth and other extraneous influences, analgentum is especially indicated. Even in cases where suturing is necessary, the ointment may be placed beneath the sutured flap, thus temporarily filling the wound and protecting the healing part from infection. In these cases the ointment will be absorbed or gradually expelled as the wound fills in with granulating tissue. Analgentum may be packed in the wound with a suitable instrument or expelled from an all-metal syringe for the purpose. If used in a syringe it will be necessary to heat the barrel gradually to facilitate its expulsion. In most instances this will be found to be the most

convenient manner of applying the ointment. However, the best method of making the application in a given case will naturally suggest itself to the experienced operator. The use of analgentum in cases where it is indicated will prove a delight to both patient and

FIG. 120

FIG. 121.

FIG. 120.—This radiogram shows a long-standing abscess on an upper left lateral. The root had been filled with lead. The dark line is a silver probe which was placed in the sinus while radiogram was being taken.

FIG. 121.—This shows the same case the day after the root-end was excised. The pocket is now ready to be filled with analgentum.

FIG. 122.

FIG. 123.

FIG. 122.—This radiogram shows a chronic alveolar abscess on an upper right central. The canal was filled and the root carried a good porcelain crown.

FIG. 123.—This shows the same case four days after excision of the denuded root-end and the curettement of the affected area.

surgeon; for it will prevent infection, control pain, and promote the healing process.

Radiograms showing cases in the author's practice, before and after treatment, are illustrated in Figs. 120, 121, 122, and 123. See also Fig. 124 and Figs. 129 to 137. In those cases where the lingual

plate of bone has been destroyed and a deep pocket is present, or where the abscess involves the antrum, care should be taken that the root-end, when excised, does not drop into the deep pocket or antral

FIG. 124.—This radiogram shows an abscess which developed on the distal root of a lower molar, after the mesial root had been previously excised and a bridge adjusted. Thorough curettement and keeping the pocket filled with bismuth paste cured the condition. The abscess was of the pericemental variety, and was doubtless caused by injury to the alveolar process and pericemental membrane, produced in the removal of the excised mesial root.

cavity, as it is often difficult to locate and remove. Such a case is illustrated on p. 452 in Fig. 108. It is a good plan in such cases to drill a small hole through the end of the root through which a small

FIG. 125.

FIG. 126.

FIG. 125.—This shows a tumor which developed in the apical area of a central incisor which carried a Richmond crown. The tooth had been improperly treated.

FIG. 126.—This shows a central incisor carrying a Richmond crown. Pink gutta-percha can be seen in the apex of the original (*A*,) showing that the root was perfectly filled at first; but in drilling for the dowel subsequently the dentist punctured the root, afterward forcing gutta-percha through the puncture (*B*). An abscess developed, doubtless from lack of asepsis.

wire may be inserted and bent to form a hook. Then, when the root-end is excised, it can be easily removed with the wire without danger of being lost.

Other complications are illustrated in Figs. 125 to 128.

Whenever the operator is in doubt as to the best means of treating complicated alveolar abscesses, he should not hesitate to consult with a practitioner who has had more experience in treating these cases. Such a course cannot be construed as evidence of lack of knowl-

FIG. 127.

FIG. 128.

FIG. 127.—This radiogram illustrates a case where three of the lower incisors contained dead pulps, causing an abscess with a common sinus which opened externally under the chin, just to the right of the median line. The dentist had been treating the abscess by washing through the left central only and sinus, finally filling the root. The case failing to heal after several months' treatment, the patient was referred. The radiogram shows, as stated, that the right central and lateral were also involved. By sterilizing the contents of the canals of these teeth and forcing phenolsulphonic acid through the sinus, the case seemed to heal. It was necessary, however, to operate and curette the area.

FIG. 128 shows the external sinus before treatment.

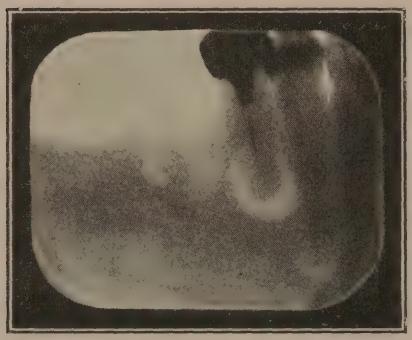

FIG 129.

FIG. 130.

FIG. 129.—This abscessed tooth was treated and the canal filled in Nov., 1911, when radiogram was taken. As might have been expected the sinus did not heal. Apicoectomy was performed Dec. 11, 1911.

FIG. 130.—This picture shows the same case and was taken Mar. 21, 1914. The tooth is solid in the jaw and perfectly comfortable.

edge, but of conservatism and progress. The foci of infection about the teeth, as in all other parts of the body, *must be removed*. We should not let the extraction of a tooth, or any number of teeth, stand in our way in accomplishing this end; but the author's clinical experience leads him to the belief that many good men to-day are

unnecessarily advising the extraction of teeth as the only means of eliminating focal infection in the mouth. This result has followed the contention of Price and others who have been confusing "presence of germs" with "infection." Because streptococci have been

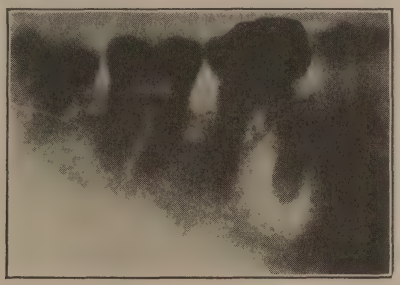

FIG. 131.

FIG. 131.—This case is from the practice of Dr. W. D. N. Moore, of Chicago. The patient had a perfect set of teeth and all in health, except this lower first molar. It was almost impossible to get through the mesial canals for treatment. The canals were filled and patient referred for operation in about 1915.

found in the canals of teeth involved or, in some instances, in regenerated bone about the root-ends of such teeth, by cultures difficult to make under the conditions without contamination, the claim has been made that such teeth or such bone is infected and therefore the teeth should be removed and the bone curetted. Much harm has

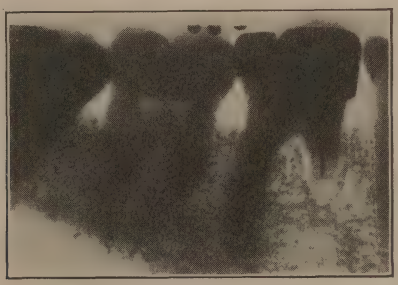

FIG. 132.

FIG. 132.—This picture shows the same case about four years after operation. The operation required less than 20 minutes to perform. The author has not seen the patient since. The post-treatment was done by Dr. Moore, who furnished radiogram for this Figure. Notice the new lamina dura around the shortened root.

followed as the result of this, now known to be, erroneous contention. In all such questionable cases, it is of prime importance that "presence of bacteria" be differentiated from presence of bacteria plus *inflammatory reaction* or *infection*. According to pathologists infection is the successful invasion of a tissue by microparasites with cellular change and inflammatory reaction.

FIG. 133.

FIG. 134.

FIG. 135.

FIG. 136.

FIG. 137.

FIG. 133–137.—This case was treated by Dr. Fred W. Gethro, of Chicago. In his treatment of root canals Dr. Gethro depends largely on mechanics, using very little medicaments of any kind. The patient was a junior student at the time (1914) in the Northwestern University, Dental School. Fig. 133 shows the case before treatment and Fig. 134 immediately after the canals were filled; when the case was operated by Dr. George E. Meyer, of Chicago as shown in Fig. 135. The radiogram for Fig. 136 was taken in 1920, six years after the root treatment and surgery. The last radiogram for Fig. 137 was taken in Oct., 1925. At this time the author met the patient, Dr. S. B. Barteau who is now practicing dentistry in Chicago, for the first time and examined the case.

In relation to this phase of the subject, Pollia of Los Angeles, in about 1920, made a series of bacteriologic tests which to date have never been disproved. This author says:[1] "The thought that some of these reported bone "infections" might be merely "presence" of bacteria, especially when satisfactory radiographic reproduction of the bone indicated no pathologic variations whatever, led me to make a series of experiments to see if it were possible to obtain cultures from normal bone tissue in the jaws. We know that the lacuna which holds the bone cell has coming from it canaliculi. These canaliculi communicate with canaliculi of other lacunæ, and in turn with the lymphatics of the periosteum. The lymphatics of the periosteum communicate with those of the mucosa. The function of the canaliculus is supposed to be for the passage of nutritious fluids. Since these canaliculi are indirectly connected with the lymphatics of the mucosa, and since the lymphatics of the mucous drain the bacteria and their products, it occurred to me that bacteria could pass through the channels and find their way into bone tissue through the medium of the canaliculi and their anastomoses." Then after explaining the careful aseptic technic of his experiments, Pollia reports, "Out of 39 pieces of spongy normal process removed, 12 gave positive cultures of streptococci." This, let it be remembered, is about 31 per cent. Haden in his work reports that about 40 per cent. of the areas around pulpless teeth which show the result of bone involvement by the *x*-ray, such as are generally classed as radiographically positive, were found to be sterile, at the time the cultures were made; and this author concludes: "These infections have doubtless run their course and have become sterile as happens with infections elsewhere in the body."

Until these investigations are proved incorrect, it should be remembered that mere presence of bacteria or radiolucent areas in themselves are not sufficient evidence on which to condemn pulpless teeth. In making our decision the condition of the patient should be the deciding factor. If the resistance of the patient is lacking as evidenced by constitutional disorders, it would certainly be a mistake to permit such a patient to continue with the overload when it could be reduced or perhaps entirely corrected by the judicious extraction of certain infected teeth. But in the absence of systemic involvement, which is indicative of normal resistance and which can quite readily be ascertained without unduly frightening the patient, we have an entirely different condition with which to contend. Bone regeneration around the root-ends of pulpless teeth must be considered

[1] Dental Items of Interest, May, 1922.

normal until proven otherwise by further research and investigation. Bacteriologic tests cannot be accepted as proof to the contrary at the present time.

In this field of work and investigation physicians and dentists should cooperate. When there is infection present, however disclosed, it is the plain duty of the dentist to eliminate the infection. How it shall be done the physician should be, and in most instances is, willing to leave to us. In the handling of patients the practitioner who follows the dictates of his own conscience will seldom go wrong; and he who applies the Golden Rule in his dealing with human affairs will find conscience an ever ready and an ever willing guide.

TREATMENT OF GANGRENOUS PULPS AND ABSCESSES IN DECIDUOUS TEETH

Before taking up the treatment of the conditions under consideration in the mouths of children, it is well to direct attention to the fact that the highest duty of the dentist today is to guard and watch the mouths and teeth of the children intrusted to his care. In times past, this necessity has not been recognized to the extent that its significance merits. It was left to Dr. A. C. Fones, of Bridgeport, Conn., and a few other earnest workers, to stamp this fact indelibly upon the minds of conscientious dentists everywhere. Beginning in 1912, and extending over a period of six years, Dr. Fones demonstrated the value of prophylaxis in mouths of school children. By a thorough and rigid system, carried on by dental hygienists under his direction the incidence to dental caries in the mouths of all the school children of Bridgeport, from the first to the sixth grade inclusive, was reduced 50 per cent. over this period of time. Nor was this all; the incidence to communicable diseases was greatly reduced. Diphtheria was reduced 50 per cent.; measles, 75 per cent.; and scarlet fever, 96 per cent. These facts should ever be in mind, and no dentist should be guilty of neglecting the mouths and teeth of the children in his practice. It is the most important work in the dental office.

In treating gangrenous pulps and abscesses in the mouths of children, it is necessary in most cases to modify our usual method of treatment. Our first duty here is to gain the confidence of the child. If the abscess is associated with a deciduous molar which we would desire to save for at least a year or two, it can be treated nicely in the following manner: After gaining the confidence of the little patient the mouth can be rinsed with an antiseptic solution—one which has a pleasant taste. Then open into the pulp chamber and place a pledget

of cotton in the opening. Now mix on one end of the cement slab thymolized calcium phosphate and the formocresol remedy, making a stiff paste. On the other end of the slab have a quick-setting cement ready to mix. Again rinse the patient's mouth and, keeping the cavity as dry as possible, gently pack the paste into the pulp chamber and flow the cement over it, filling the cavity. It is remarkable how rapidly these abscesses will heal and remain quiet when treated in this manner, provided, of course, there be no caries or necrosis of bone, which condition is rarely found in the mouths of children as the result of abscess from deciduous teeth. If it is desirable to keep the tooth in the patient's mouth for more than a year, it is better to neutralize the putrescence with formocresol as usual, when the root-canals can be flooded with chloroform and eucapercha compound, and the entire cavity filled with gutta-percha. The gutta-percha filling, if properly inserted, will last as long as is necessary to save the tooth, even in occlusal cavities where it is exposed to the stress of mastication. The filling of the canals of deciduous teeth with Dentinoid will be described later (see page 480).

PERICEMENTAL ABSCESS

GENERAL CONSIDERATIONS

All of the alveolar abscesses which we have discussed thus far have been the result of an infection in the periapical area, the infection being due to pathogenic bacteria, poisonous ptomains, toxins and irritating gases, which have escaped from a gangrenous root-canal. There is, however, an abscess that occurs in the alveolar region about the roots of teeth, and is not due to the causes mentioned. This particular kind of abscess occurs in connection with live teeth; not necessarily so, however. There is a progressive breaking down of the pericemental membrane, which in dental literature is called a *pericemental abscess*. The origin of this particular kind of abscess is rather vague; but it is generally supposed to be due to some traumatic injury, the infection being blood-borne or hematogenous. It frequently occurs on the mesial, labial or distal surface of the roots of the anterior teeth involving most of the surface. The lingual surface of these teeth is seldom involved. It has also been known to occur between the roots of molar teeth, especially upper molars. It may discharge through a sinus near the apical end of the roots or at the gum margin; in the latter case it resembles a pyorrheal pocket.

THERAPEUTICS

For convenience in outlining our treatment for a pericemental abscess, the condition may be classified as *acute* and *chronic*. As a rule, there is very little pain associated with either variety of pericemental abscess. In the acute form, which, as such, is extremely difficult to diagnose, the patient will complain of "something being wrong with a particular tooth." About all that can be done therapeutically with the acute form is to pacify the patient, as best we can, until the acute abscess develops into the chronic variety, when pus is formed and discharges and a sinus is established; thus the diagnosis is more easily made. In those cases where the sinus opens on the labial or buccal surface of the gum and not at the gum margin, care should be exercised in the diagnosis so as not to confuse the condition with an abscess of the ordinary variety, and open into vital teeth. A case where an incorrect diagnosis was made is illustrated in Fig. 138.

If the abscess occurs on the anterior teeth where the area involved can be curetted or cauterized, it will generally yield to the treatment; but the treatment of a chronic pericemental abscess on molar teeth is at best a discouraging procedure. If it is possible to thoroughly curette the area the tooth can be saved, provided the surrounding surfaces are kept clean. In those cases where the area can be reached, an opening, if necessary, can be made through the gum, the root thoroughly scraped and polished; then, after washing out the abscessed area, it should be cauterized with some cauterizing agent. Nothing gives better results than phenolsulphonic acid.

FIG. 138.—This radiogram partially shows the result of an incorrect diagnosis, where a pericemental abscess was mistaken for an alveolar abscess. The abscess occurred between the roots of the upper right central and lateral incisors with a sinus opening on the labial midway between the gum margin and the apex of the central incisor. The case gave a history of having received a blow on these two teeth about two months previous. The dentist, thinking the pulp in the central was dead, deliberately opened into the vital tooth. The patient then went to another dentist who attempted to remove the pulp by pressure anesthesia. It was difficult to anesthetize and a remnant was left in the apical area. Acute pericementitis followed and nitrous oxid and oxygen were administered and the remnant removed. This only aggravated the pericemental trouble; the cavity was left unsealed and the crown of the tooth became dark blue in color. The patient was now referred. Two treatments of phenol compound cured the pericementitis, when the root was filled. Subsequently the tissue about the abscess was anesthetized, the area curetted, and the wound packed for twenty-four hours with sterile gauze saturated with euroform paste. Two subsequent injections of bismuth paste cured the case; after which the color of the tooth was restored by sealing caustic pyrozone in the cavity, when a gold inlay was inserted. The patient in this instance was a lady, and when we recall that the tooth involved was an anterior one, the seriousness of the mistaken diagnosis becomes all the more apparent. The canal was filled in 1914, and at this writing, 1925, the tooth is healthy and rendering good service.

With a proper glass syringe and a gold or platinum needle, the remedy can be injected into the abscess pocket. One thorough treatment should effect a cure. In curetting these cases it is far better to go a little beyond the affected territory rather than fail to remove all of the affected tissue and have the abscess recur. Where the abscess can be reached, thorough curettement without cauterization will effect a cure. That portion of the pericemental membrane which has been destroyed will, perhaps, never be regenerated, but if we succeed in

having granulations fill in the area involved, even though the membrane is not regenerated over that particular surface of the root, the tooth can be saved for a considerable length of time (see Figs. 139 and 140.)

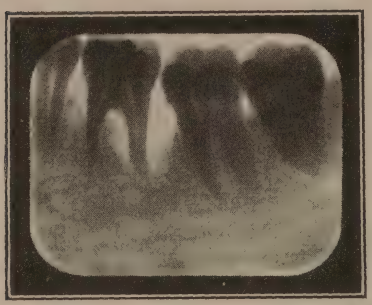

FIG. 139.

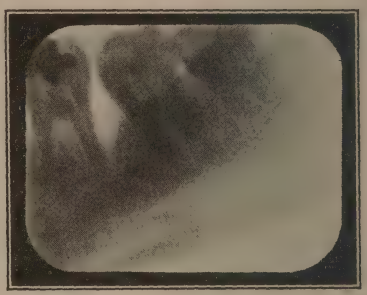

FIG. 140.

FIG. 139.—This radiogram shows a pericemental abscess on the distal root of a lower first molar. The patient, a lady, has a perfect set of teeth and gums healthy except this area. The part was anesthetized with a local anesthetic, the gum lanced freely on the buccal, the root scaled and area curetted. The exposed root being hypersensitive was subsequently cauterized with silver nitrate. The abscess yielded to the treatment. The cause of this particular abscess was a wooden toothpick having been broken off between the teeth.

FIG. 140.—The case illustrated in Fig. 139 was treated in April, 1916. This radiogram was taken Jan. 16, 1917. Notice the bone regeneration between the roots and the absence of deposits which show plainly in the negative for Fig. 139. The tissues around the tooth are as healthy as though no infection had ever been present, and there is very little depression of the soft tissues between the first and second molars.

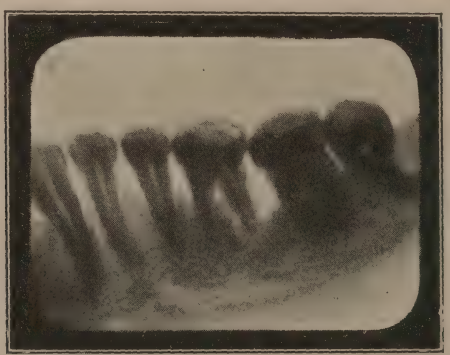

FIG. 141.—A case similar to that illustrated in Fig. 139, in the mouth of a male patient. Treated in the same manner, with a good result.

FILLING ROOT-CANALS

GENERAL CONSIDERATIONS

The operation of filling root-canals stands as a sort of dividing line between the subjects of Therapeutics and Operative Dentistry proper. There has been a great variance of opinion in the past regarding the methods and materials used for this purpose. The method employed in this operation depends largely upon the materials which the individual operator uses, and a great variety of materials have been suggested and used, among which the following may be mentioned:

1. *Cotton.*—Saturating it with such antiseptics as creosote, iodoform, etc.

2. *Zinc Oxychlorid Cement.*—Chemically pure zinc oxid (powder) and a saturated solution of zinc chlorid (liquid). Some operators advise filling the apex with soft gold and the canal proper with the cement.

3. *Paraffin.*—Using the material alone or in combination with such agents as bismuth oxid, etc.

4. *Medicated Pastes.*—A variety of such pastes have been used, the powder for which consists of zinc oxid as the base with thymol, alum, chinosol, etc., in varying proportions; the liquid containing formaldehyd in solutions of different strength in such liquid drugs as phenol, cresol, creosote, etc.

5. *Gutta-Percha.*—Using the material in solution in such solvents as chloroform, eucalyptol, and oil of cajuput. In connection with the gutta-percha solution, gutta-percha points, gold, copper and lead wire, etc., have been employed. Gutta-percha is now used with the author's Dentinoid.

In the light of our knowledge to-day of focal infection, it would be fortunate indeed if it could be correctly stated that all of the materials above mentioned, except gutta-percha, had been discarded; for all, with the one exception, have been tried and found wanting. The radiogram has proved the correctness of this statement.

In the opinion of the author, which is shared by men like Rhein, Black, Callahan, and others, gutta-percha, modified and used in such a manner as to best meet the needs of the individual operator, is the only material at our command to-day upon which reliance may be placed. From experiments made, Price is even skeptical regarding

gutta-percha on account of its inherent tendency to shrink; but against his laboratory experiments stands the record of thousands of clinical cases which proves conclusively that this material, properly used, answers our every purpose for filling the canals of pulpless teeth. This being true, the proposition resolves itself into the problem of determining the best method of modifying and using the material.

We may modify the properties of gutta-percha by incorporating within its substance certain drugs; and drugs are added to root-filling materials for two purposes: One a *pharmaco-mechanical* reason; the other on a *therapeutic basis*. In the case of gutta-percha,

FIG. 142.—These teeth were treated and the canals filled in November and December, 1902. The radiogram was taken Apr. 3, 1916, over fourteen years after the three teeth had been treated. While there is no infection at the end of the roots, though none of the canals are well filled, this is an exception to the rule and will not excuse any dentist for not filling the canals of teeth to-day better than they have been filled in the past. Notice the mental foramen between the bicuspids. Many times this appears in a radiogram near the end of a bicuspid root, and may be mistaken for a "rarefied area." The mandibular canal may also show near the end of a lower molar (see the distal root of Fig. 57).

it is admissible to add to and use in connection with the material such drugs as chloroform and eucalyptol, for pharmacal and mechanical purposes. In the opinion of Callahan, even rosin may be added on this basis. The solvents, chloroform and eucalyptol, soften the material which permits its adaptation, by proper manipulation with heat and instruments, to every irregularity in the canal which has been cleaned and opened by the previous treatment—thus the latter is completely filled with a nonabsorbable, and, if properly manipulated, I believe, nonshrinkable material. Gutta-percha may now be used successfully with a minimum amount of solvent.

Whether or not we are justified in adding drugs to root-filling materials to-day for therapeutic purposes is a debatable question. Speaking of the use of the many so-called "permanently antiseptic" root-filling pastes of various kinds that have been advocated and used, Best says:[1] "The only possible excuse I can see for the use of

[1] Dental Items of Interest, July, 1915, page 508.

these preparations in the roots of teeth is that the operator knows he has left something in the root which he should not have left; and instead of removing it, he places his 'life-saver' in on top of it and then rests assured he 'will have no trouble' from it in the future." When we remember that to which I have repeatedly directed attention, viz., there is no such thing as a permanently antiseptic root-filling material, we cannot rightfully have this satisfying assurance. That gutta-percha aseptically introduced in an aseptic canal will remain aseptic for years is the firm belief of the author and others, based upon years of clinical experience and observation. We have no right to fill a canal of a tooth which requires an antiseptic, as such, in our filling material. By this it is meant that in case the canal is not aseptic, it should not be filled until it is in this condition. Referring again to Best, he makes the statement "that the only solution lies in an almost entire nondependence upon antiseptics in canal fillings and in the maintaining of asepsis in the operation." I fully agree with the first part of the statement that we should not depend upon antiseptics, as such, in our root-filling material; but I firmly believe in the liberal and generous use of antiseptics, and in the careful and intelligent use of disinfectants, in establishing and maintaining asepsis in treating pulpless teeth and preparing the canals for filling; and there is no good reason why certain carefully selected antiseptics should not be a constituent of root-filling materials.

Precautions.—It will be remembered that three factors were emphasized under the Removal of Pulps and the Subsequent Treatment, viz.:

1. Establish and maintain asepsis.
2. Preserve the color of the tooth.
3. Thoroughly fill the canal.

The author suggests filling all canals, for reasons previously mentioned, with gutta-percha in the manner which will be subsequently described. In connection with the preservation of the color of the tooth, it should be mentioned that *white base plate gutta-percha* should be used, especially for the purpose of dissolving in eucalyptol, making *eucapercha*. If this white substance is forced into the tubuli of the crown of the tooth, as it is liable to be, it will not change the color of the tooth-structure as would the pink gutta-percha. A great many dentists have been moistening the canal, previous to filling with gutta-percha, with *oil of eucalpytus;* and, as a result, much unnecessary pericementitis has followed this operation. If oil of eucalyptus is used at all, the refined oil only should be selected; and far more satis-

factory results will follow the use of *eucalyptol*, the most volatile constituent of oil of eucalyptus. While eucalyptol is irritating, it is not nearly so much so as is oil of eucalyptus. The author suggests modifying the irritating property of eucalyptol and enhancing its antiseptic power by combining menthol and thymol, as suggested in the prescription of eucalyptol compound in the discussion of Nonseptic Pericementitis (p. 431). In this proportion, the agents added do not interfere with the solvent power of eucalyptol for gutta-percha; but if the amounts are increased to any appreciable extent, this does not hold true. Oil of cajuput has also been used for moistening the canal; but it has no advantage since its constituent, *cineol*, is chemically identical with eucalyptol.

In filling root-canals it is always the safest practice to adjust the rubber dam, *for asepsis must be established and maintained.* The same agents may be used for sterilizing the teeth after the dam is adjusted as were described in removing pulps by the Anesthetization Method. The canals should be aseptic before the operation is attempted. If there is any doubt in this regard, the operation should be deferred until they are in such a condition. Not only should the canals be sterile; but all instruments and material should be germ free. Methods of accomplishing this end were considered under Dental Sterilization (p. 323), and no dental office or Dental Infirmary is completely equipped without adequate means for sterilization. The instruments may be sterilized by moist heat, the cotton wrapped on broaches, and other such material may be sterilized by dry heat; but it is necessary to rely upon chemic agents for sterilizing the gutta-percha points. The latter should always be sterilized when first purchased by immersion for a few hours in modified alcohol or other suitable disinfecting solutions, when they may be removed and placed on sterile gauze to absorb the liquid, thus dried and put in gelatin capsules, Petri dishes, or other sterile containers. Even with this method of keeping the points, it is well to place them in modified alcohol a few minutes before they are used. Though it may be done, it is impracticable to sterilize the hands and keep them germ free throughout the operation; and it is not necessary to have them absolutely sterile, if the cotton on the broaches was sterilized by dry heat after being wrapped, as first suggested by Best. This is the safest practice.

If the author's suggestion has been followed in regard to using eucalyptol compound for the final dressing in treating pulpless teeth, the canal will generally be in condition to fill, so far as moisture is con-

cerned, when the dressing is removed. Black states[1] that "moisture is effectively removed by flooding the canals previous to filling with eucalyptol or oil of cajuput. The oils have a greater affinity, or attraction, for the dentin than has the moisture, therefore, displace it." If testing with sterile cotton or an absorbent point indicates moisture in the apical end, it should be absorbed before attempting to fill the canal. Overdrying with heated air or instruments should be avoided.

Filling Large Canals.—In filling large canals, especially those in connection with which dental granulomas or alveolar abscesses have been treated, where the apex is large and where we ought not to expect to get a response from the patient when the gutta-percha cone reaches the apex, on account of the loss of tissue in the periapical area, it is best to measure the canal and then use one cone which approximately fits it rather than use two or three smaller cones with the possibility of unnecessarily forcing one through the apex and into the periapical area. To measure the canals, sterile absorbent points may be used. When after repeated trials the sterile point fits the canal, a cone should be selected which is slightly smaller than this particular point. The canal should now be moistened with chloroform, then a small amount of eucapercha introduced, the latter being worked up or down into the canal with a fine smooth broach, exhausting the air. If cotton is wrapped around the broach used for this latter purpose, only a few shreds should be used; for we should avoid making a piston out of the broach and thus defeat our object of exhausting the air. This accomplished, the selected cone, flattened on the large end, should be dipped in chloroform and placed in the canal; when it should be worked up and down a few times with a slight pumping motion. In this manner the chloroform and eucapercha soften the outer surface of the cone, leaving the central portion with sufficient resistance to cause the mass of gutta-percha to spread laterally as the cone is finally pressed to place with the pliers. Root-canal pluggers may now be used and the mass of gutta-percha firmly packed in the canal. If chloroform is used, very little heat is required to soften the cones. The final packing may be done with a tampon of cotton or Japanese bibulous paper saturated with chloroform, as suggested by Rhein. In filling large canals from which live pulps have recently been removed, the patient will generally flinch before the cone reaches the apex. When this occurs, we should wait a few minutes, when the cone can be gently pressed much farther without causing the patient to flinch

[1] Special Dental Pathology, p. 328.

a second time. If these precautions are observed, they will be the means of preventing much of the pericementitis following the filling of root-canals.

We should make every endeavor to have our sterile root-filling reach at least to the end of the root; and Rhein has repeatedly emphasized what he believes to be the necessity of encapsulating the apical end of the root with the fluid gutta-percha, in all cases where gangrenous canals had been treated which in any way involved the periapical tissues. The author believes this to be a questionable procedure and that those cases demanding such treatment are highly questionable ones, viewed from the health standpoint of the patient; and again let us remember the results of the researches of Hatton and Puterbaugh where they find the pericementum intact in most of these cases. Where this is not the case, apicoectomy or extraction is plainly indicated. In clean cases it is not necessary for the filling material to protrude beyond the apex, though it is difficult to fill canals as they must be filled for success without having the material pass through the apex to a greater or less extent. Fortunately the tissues take kindly to sterile gutta-percha; but it should not be deliberately forced through in plastic form with the idea of encapsulation.

Filling Small Canals.—In filling all canals where we can enter nicely with a small canal plugger, it is best to follow the technic outlined above, using a cone which will enter the canal. However much we may regret it, there are canals, especially in molar teeth, so small and tortuous that only a fine, smooth broach will enter, at least to any depth. It is useless to try to fill such canals with a gutta-percha cone. The methods of enlarging the canal by the use of acids and caustics, as referred to in connection with the destruction of pulp tissue in such canals, can be employed; but it is not always advisable to enlarge them sufficiently to admit a cone of any appreciable size, and there is no resistance to a very small cone, especially after it has been softened with solvents or heat. After the larger canal or canals in a multi-rooted tooth are filled in the ordinary manner, the smaller ones can be moistened with chloroform and eucapercha and the solution worked up or down into the canal. This process should be kept up for some time until the chloroform evaporates, leaving the gutta-percha rather thick and quite plastic. The sides of the pulp chamber can now be moistened with eucalyptol compound and a piece of base plate gutta-percha, selected and softened in the flame, can be packed into the pulp chamber, when pressure can be made toward the small canals and the plastic gutta-percha forced into them. This is much better practice than simply filling the mouth of the canal with a

gutta-percha cone, leaving the rest of the canal empty. If the canal is so small and tortuous that even a small broach will not enter, and if it cannot be enlarged by the use of acids or caustics, as referred to previously, it will be necessary either to extract the tooth, or record the fact and occasionally check up on the case with a radiogram to ascertain if any infection is present at the end of the root. In every case where it can be done, the gutta-percha in the canals should be protected by zinc oxychlorid cement (see Fig. 143). This may be done in all cases except those where it is necessary to subsequently insert a post in the canal for some purpose.

The technic of filling root-canals with gutta-percha, as described by different operators, varies slightly, as, for instance, in the drugs used as solvents and in the manner of introducing and packing the material in the canal. Gethro, Coolidge and others believe they can get a more compact mass of gutta-percha in the canal by cutting the points and introducing them in small pieces. Whatever method is employed the gutta-percha must be left firmly packed in the canal; and it is the duty of every dentist to use this material in filling root-canals according to the method which in his hands offers the greatest opportunity for success. The operation is one that requires attention to detail, and, the canals of a sufficient number of extracted teeth should be filled until the operator is satisfied he has mastered the technic of the method employed. All cases of root-fillings should be radiographed and a careful record kept. If in treating pulpless teeth, preparing the canals for filling, and in root-filling operations, the dentist always tries to do his best, he will be rewarded by finding that the radiogram will prove his best is very good.

Callahan's Rosin Solution.—A discussion of filling root-canals would not be complete without mention of *Callahan's rosin solution.* The formula follows:

℞—Resinæ,	gr. xii (0.75 Gm.)
Chloroformi,	fl. ʒiii (12.0 cc.)—M.
Sig.—Use as directed.	

In directing attention to the method of using this solution Callahan says:[1] "Most of us at some time or other have shared in the opinion that it mattered but little what material was used in filling root-canals. It does matter as to the material; it does matter as to the manner of placing the material in the canal. The matter of prime importance is the sealing of the more or less numerous foramina, and, as we have no assurance that all of the foramina in a given root-

[1] Dental Items of Interest, 1915, p. 585.

canal are located near the apex, it becomes our duty to seal the whole of each canal with a material that will search out and seal minute canals or openings which, owing to physical conditions, we are unable to see."

Technic.—After desiccating the canal, observing strict asepsis, the latter is flooded with the thin rosin solution, pumping it up or down into the canal. When the latter is full of the solution, the air is exhausted by passing a fine wire or broach to the end. A gutta-percha cone which reaches to or near the end is selected and gently placed about half-way within the canal; the cone is pumped up and down, from forty to sixty times, and, as it dissolves in the chloroform, it is advanced farther toward the apex. This pumping motion forces the rosin solution, according to Callahan, into every opening, sealing all tubuli and foramina that have been opened in the preparation of the canal for filling. If this does not leave the large end of the gutta-percha cone at or near the mouth of the canal, a smaller cone may be placed and packed into the mass with cold root-canal pluggers, using warm air to soften the protruding gutta-percha, if necessary. This packing forces the semifluid chloropercha and rosin into the unknown canals and pockets, and, at the same time, brings the surplus chloropercha to the mouth of the canal, where it may be removed with cotton.

The author can see no advantage in the addition of rosin used in the manner here suggested, for the chloroform solution will only enter the tubuli as far as moisture has been removed. It is difficult in the mouth to deplete the tooth-structure of its moisture, and, were it possible, it is questionable whether it ought to be done.

Dentinoid for Filling Root-canals.—The use of dentinoid for pulp protection has been discussed elsewhere (page 359). This product serves a most useful purpose for filling the canals of pulpless teeth. For some time it has been given every clinical test, and its use has proved a step forward in the conservation of both the dental pulp and the pulpless tooth.

When dentinoid is used for filling the canals of pulpless teeth ordinary alcohol may be used in making the mix, which should be rather stiff and plastic. It is presumed that alcohol is the liquid last used in the canal for removing the surface moisture, which is all that is necessary when this method of filling root-canals is followed. Some of the alcohol thus used is purposely left in the canal, better results being obtained when the canal is slightly moistened with this liquid. With a suitable instrument the plastic dentinoid is placed in the canal and worked to the very end. Now take a gutta-percha

cone, which has been previously selected and tried in the canal, and dip it in eucapercha compound, eucalyptol compound or chloroform, whichever the operator prefers; then place it in the canal as far as it will go. For softening the surface of the gutta-percha cone, eucapercha compound is recommended and for this purpose it should be kept quite thin by the occasional addition of eucalyptol compound. If the cone has been properly selected it should pass easily through the plastic dentinoid and nearly reach the end of the canal. Other gutta-percha cones may now be treated likewise and introduced until no more can thus be placed. With a suitable root-canal plugger or ball purnisher, slightly heated, the gutta-percha should be firmly packed in the canal. The plastic dentinoid will be quite stiff by this time and is intended to seal the foramina and tubuli as well as fill and seal any lateral openings which may lead from the main canal. The gutta-percha is used largely for radiopacic purposes, though its employment here aids materially in packing the dentinoid firmly in the canal, *which is absolutely essential*. With this in mind the first cone introduced should nearly reach the end, otherwise a good root-canal operation may be questioned; for dentinoid is not definitely radiopacic. It should be remembered that the radiopacity of a root-filling material adds nothing to its value as such; but in recent years the profession has been trained to look for such a root-filling and for this reason gutta-percha is recommended in combination with dentinoid when used for filling the canals of pulpless teeth in the adult mouth. In deciduous teeth dentinoid should be used alone, as will be mentioned later.

In clean cases, like in pulp removal with no periapical envolvement, or where no opening has been made by pathologic process or instrumentation, it is best to have the gutta-percha stop just short of the end, with the dentinoid packed firmly beyond. But where there is an opening of any size, however, made, the selected gutta-percha cone should fit the opening. Thus when finally introduced the latter may be closed with gutta-percha and very little, if any, of the plastic dentinoid forced into the apical area (see Fig. 144).

In those cases where there is a large opening through the end of the root, caused by destructive disease with loss of considerable bone in the periapical area, especially where apicoectomy is indicated, it is recommended that a lead point be substituted for the gutta-percha cone and the canal filled in the same manner. If the lead point has been properly fitted to the canal it may be pushed through the plastic dentinoid and malleted home without danger of protrusion through

the root-end, and the dentinoid will seal the tubuli and fill all spaces not occupied by the lead filling.

In cases where the canal is so small that a gutta-percha cone cannot be used to advantage in combination with dentinoid, the entire canal may be filled with the latter material with every confidence of success; though it should be remembered that the root-filling will not be definitely radiopacic. For this reason, where it can be done, the canal had better be enlarged to admit of at least one gutta-percha cone. Should dentinoid be used alone it may be packed as directed for filling the canals of deciduous teeth.

FIG. 144.—This case is reported from the practice of Dr. M. Evangeline Jordan, of Los Angeles, Calif. The patient, 11 years of age, had been under orthodontic treatment for about eight months. The upper lateral incisor, shown in the radiogram, was found to contain a dead pulp with a discharging abscess. The tooth was abnormally small. On opening into the lingual surface, a pulp stone was encountered at the mouth of the canal. This was removed after some difficulty and the tooth treated in the usual manner. The case is shown here because of the pulp stone which is unusual in teeth of this age, and also because it illustrates a condition of a large open root-end wherein the use of dentinoid in filling the canal is of value, using either a single gutta-percha cone or lead.

Deciduous Teeth.—For filling the canals of deciduous teeth, dentinoid is the ideal material to use. Here the entire canal should be filled with dentinoid, which should be firmly packed to the end. The canal should be desiccated with alcohol, leaving some of the liquid in when the mixed material is introduced. The mix should be made quite stiff, adding a drop of alcohol from time to time to retard the setting. The dentinoid may be carried to place with a cotton-wrapped broach or other suitable instrument, keeping the paste sufficiently thin that it may be carried to the end before the packing process is begun; and pack from the end to the orifice with a cotton-wrapped canal plugger or unvulcanized rubber, until the canal is full and the dentinoid firmly compressed. Undue pressure is not necessary; though it is well to push a sharp stiff broach through the mass

as the packing is done to insure that the material is being packed from the end and not binding and packing at some point midway in the canal. When the canal is filled, cover at once with zinc oxychlorid and fill the cavity at this or a subsequent sitting. In these cases the dentinoid root filling should be resorbed with the tooth root.

Clinical Observations.—When a mix of dentinoid of some thickness is permitted to set on the mixing slab, it will be noticed on examining the specimen that the exposed surface is much harder than the center or that next to the slab. This is due to the fact that when the liquid leaves the mass it brings the binder and antiseptics to the surface. This means that in the canal of a tooth the dentinal tubuli and foramina are sealed with this hard, compact, medicated and adhesive material.

Dentinoid adheres firmly to every surface of the tooth structure with which it comes in contact; but should it become necessary for any reason to soften the material in a cavity or canal of a tooth, it may be done as often as is required without detriment by simply adding the liquid used in making the mix; and when softened the second or third time, it will reset as quickly as it did in the first instance, providing of course, in the case of a root filling, that too much of the binder has not been removed by the absorbent cotton in introducing and packing the material in the canal. This is a distinct advantage which a purely physical mixture has over a chemic combination.

In using dentinoid for filling the canals of pulpless teeth, it should be remembered that the material will become stiff at once, or as soon as the liquid is permitted to evaporate; but that it requires a few hours for it to set firmly. In those cases where the root-filling need not be disturbed for a post or dowel in some contemplated reconstruction work, it makes no difference about the delayed setting of the dentinoid, as long as it is known it will ultimately set without shrinkage under the conditions and become extremely hard and resistant. When it is desired to use a post before the dentinoid sets firmly, only the apical half of the canal need be filled and this covered with zinc oxychlorid or other quick-setting cement.

Conclusions.—Used for filling the canals of pulpless teeth in combination with gutta-percha dentinoid has many advantages. Gutta-percha has had a long and satisfactory record here. The only objection to its use for this purpose has been its inherent tendency to shrink under the conditions as used in the past. *Gutta-percha, as such, does not shrink.* No one will dispute this fact. The shrinkage of the material in root-canal surgery has been caused by the

necessary solvents used by the old methods. With gutta-percha used, practically without solvents, in combination with dentinoid, as here suggested, we eliminate the only objection to this long-used, dependable and reliable material. In his recent work[1] Price states, "Root-fillings rarely fill pulp-canals sufficiently perfectly to shut out bacteria, completely or permanently. Root-fillings usually fill the pulp-canal much less perfectly some time after the operation, than at the time of the operation, due to the contraction of the root-filling material. The ultimate volume of contraction of the root-filling is approximately the amount of solvent used where a solvent is used with gutta-percha as a root-filling material. Infection is a relative matter, and quantity and danger are both related to defense, which defense may vary from high to exceedingly low." This author further states that a canal filled with gutta percha and chloroform lacks 6.6 per cent. of being full, when the chloroform has evaporated. With rosin added to the chloroform approximately 7.5 per cent. is unfilled when completely dried out. Eucapercha used, the shrinkage resulting is about the same. Price concludes by saying, "It is, therefore, a physical impossibility completely to fill a pulp-chamber with gutta-percha made plastic by any of the above solvents except at the time the gutta-percha contains the solvent."

The several advantages of the combination of dentinoid and gutta-percha for filling the canals of pulpless teeth must be obvious. By this method the dentin need not be entirely free of moisture; the removal of the surface moisture is all that is necessary. Some of the alcohol used for removing the surface moisture is purposely left in the canal which in itself is an advantage. As has been elsewhere stated, alcohol has a great affinity for water and the liquids mix in all proportions. This is an advantage in that the alcohol used in making the mix with dentinoid holds in solution the antiseptics and binder, which are carried into the tubuli when the plastic dentinoid is placed in the canal; thus the tubules are sealed with antiseptics therein contained.

Could anything be more ideal than this? Then, too, it should be remembered that the solvents (eucalyptol and chloroform) used for slightly softening the surfaces of the gutta-percha cones, are miscible with the alcohol used in making a mix of dentinoid; and not enough of these solvents need be used to materially affect the gutta-percha and cause shrinkage. Even if slight shrinkage should result, which is questionable under these conditions, it would be of no significance

[1] Dental Infections and Degenerative Diseases—Clinical—Vol. I, p. 209—Vol. II, p. 29.

here, for the foramina, tubuli and any possible lateral opening or openings are sealed with dentinoid—a *hard, firmly-adherent, medicated artificial dentin*, which aids rather than hinders nature in the healing process. In using dentinoid for any purpose it should be remembered that it is not a dental cement and should not be used as such. It is a purely physical mixture which gives the product many advantages for the purposes for which it is intended to be used.

DISCOLORED TEETH

GENERAL CONSIDERATIONS

In the discussion of the methods of removing pulps from teeth and the subsequent treatment, the treating of gangrenous pulps and the various kinds of alveolar abscesses, the author endeavored to emphasize the necessity of *preserving or restoring the color of the tooth.* There is, perhaps, nothing more annoying to a conscientious dentist and to an appreciative patient than a discolored tooth in the patient's mouth. If the precautions, which have been mentioned throughout this work with reference to this factor, are observed in the treatment of teeth, the necessity for bleaching may often be avoided; for, after all that has been written on this subject is studied, it must be admitted that the most successful method of bleaching teeth is to so treat them that they will not need to be bleached.

Sources of Discoloration.—There are three principal sources of the discoloration of tooth-structure, viz.,

1. Pulp decomposition.
2. Remedial agents.
3. Metallic fillings.

The most common source is that of pulp decomposition. Many teeth containing gangrenous pulps are discolored before the patient presents for treatment. In those cases where the color is not lost the gangrenous conditions can be corrected and the color preserved by the method of treatment outlined under Gangrenous Pulps.

Occasionally, however, teeth have been observed to assume a pinkish hue shortly after some traumatic injury, rapid regulation, or after some irritating drug had been applied to a small exposure of the pulp, as, for instance, arsenic trioxid. Kirk has offered us a very plausible explanation of this immediate discoloration. He says: "It is now known that the pink staining of the tooth is brought about by a rupture of the stroma of the red blood disks liberating their contained hemoglobin, which dissolves in the plasma, forming a solution of hemoglobin which readily penetrates the dentinal tubuli, the lumen of which is of insufficient diameter to admit the unbroken red corpuscle. This pink discoloration resulting from the infiltration of hemoglobin solution represents the first stage of tooth dis-

coloration. The pink stain readily undergoes alterations, later on assuming a brownish tint, due to the breaking down of the highly complex molecule of hemoglobin into a reduced product known as hematin."

Principle of Bleaching.—The principle which governs the successful bleaching of teeth is to chemically change the molecule of the pigment in such a manner as to destroy its color, or chemically change the insoluble coloring substance to a soluble form, when it can be washed out of the tooth-structure.

Manner of Discoloration.—There are two ways by which the discoloration is produced, *i.e.*, by solutions which stain the cement-like substance uniting the tubuli and by the ingress into the tubuli of insoluble coloring substances. For instance, many remedial agents in solution, such as oil of cassia, silver nitrate, etc., have the property of staining the cementing substance and producing discolorations; while the sulphids formed from certain metals, as, for example, in amalgam fillings, produce discoloration by virtue of being forced into the tubular structure of the dentin. If, in the treatment of teeth, more care were taken to select remedial agents which would not stain the tooth-structure, and if high-grade alloys were selected in making amalgam fillings, the cavity properly prepared, amalgam inserted and polished when set, there would be few teeth discolored from these causes. But, as has been stated, many teeth containing gangrenous pulps are discolored before the patient presents for treatment; and, inasmuch as this is by far the most common source, it is well to try to ascertain definitely the true cause of these discolorations; for it is difficult and unsatisfactory to try to bleach a tooth when we have no knowledge of the nature of the pigment we are trying to bleach.

Attention will now be directed to the cause of discoloration from pulp decomposition as the author understands it. In the discussion on the Chemistry of Pulp Decomposition, the intermediate and end-products resulting from this complicated process were enumerated and it was ascertained that ammonia, NH_3, and hydrogen sulphid, H_2S, were the principal gases formed. It was also pointed out that the relative amount of nitrogen and sulphur found in the proteid molecule was 15 per cent. of the former to 0.3 per cent. of the latter, and from this fact it was reasoned that ammonia, a compound of nitrogen and hydrogen, was generated in far greater quantities in a gangrenous root canal, than hydrogen sulphid, a compound of hydrogen and sulphur; and that this latter gas did not assume the

important role in the discoloration of teeth from this source, as had been so generally supposed.

It is quite generally conceded by those who have given this phase of the decomposition process their attention, that iron, Fe, is the most important element to be considered in the many factors entering into the discoloration problem; and it is a common statement found in our text-books and journals that the discoloration is due to the formation of ferrous sulphid, FeS, which salt is supposed to be formed by the action of hydrogen sulphid upon the iron. This view is held by many writers, among whom is Dr. Kirk, who has perhaps given more thought to this subject than any other writer. The source of iron has been considered entirely from the decomposition of the hemoglobin of the red blood corpuscles; for it is well known that this compound contains iron, which is not characteristic of all proteid bodies. Dr. J. E. Hinkins, of Chicago, in his analysis of the enamel and dentin of human teeth, found that iron existed in both of these structures in combination with aluminum. It is not unlikely that future investigation will find that the iron from this source plays a part in the discoloration of tooth structure. It remains, however, to be demonstrated that ferrous sulphid is the true cause of the discoloration and the author doubts if this theory can ever be proved to be correct. From chemistry we learn that ferrous sulphid is a *black* compound and that no change takes place in the color or otherwise by exposing it to the air. Should the discoloration of tooth structure be due, then, to ferrous sulphid, as claimed by many writers, there would be no necessity, in treating gangrenous pulps, so far as preserving the color of the tooth is concerned, for using a remedy which can be hermetically sealed within the tooth. Clinical experience shows that a tooth containing a recently decomposed pulp, in a large percentage of cases, is not discolored, and that such a tooth will not change in color if the formocresol remedy is used in the treatment and always hermetically sealed.

Dr. Kirk admits that "Ferrous sulphid, as such, cannot be held wholly accountable for the bluish-black color of the tooth which has reached the stage of permanent discoloration." Neither can the *green* nor *yellow* discolorations of teeth be attributed in any way to the presence of black ferrous sulphid; yet, the author is of the opinion that it is possible for this compound to be formed in the ultimate process of pulp decomposition as will be explained later on in this discussion. From the foregoing, it must be evident that it is necessary to search for other colored substances, besides black ferrous

sulphid which are possible to be formed in the process of pulp decomposition and which are capable of staining the tooth structure.

In articles which the author read before the Odontographic Society of Chicago (*Dental Review*, June, 1901, October, 1902), a theory was advanced which explained the variety of colors exhibited in discolored teeth, and while some criticism has been offered in regard to this theory nothing has been done now after twenty-five years to disprove its correctness, therefore, he is still of the opinion, that it presents today the most rational solution of this question from both the chemic and clinical viewpoint.

As has been stated, ammonia is not only a constant end-product, but it is generated in far greater quantities than any other gas. It is well known that ammonia has the property of uniting chemically with water, which is always present in a gangrenous root canal, forming ammonium hydroxid, $NH_3 + H_2O = NH_4OH$. This reagent will act upon the soluble salts of iron, in both the ferrous and ferric forms, producing respectively, ferrous and ferric hydroxid, $Fe(OH)_2$, $Fe_2(OH)_6$. Therefore, it is not only possible, but quite probable, that the atomic iron which is liberated in the process of decomposition, from the hemoglobin or perhaps intermediate compounds containing it, unite with the ammonium hydroxid present, forming the hydroxid of the metal; and inasmuch as the compounds containing the iron are organic or weak, the ferrous hydroxid, in all probability, would be produced. Ferrous hydroxid is a *white* compound which readily absorbs oxygen when in the moist state and exposed to air, and gradually changes to ferric hydroxid, a *reddish-brown* compound. In this change there is an array of four distinct colors—*white*, *green*, *black* and *brown*—and in the blending of these four colors there is produced every variety of shades exhibited in discolored teeth. This seems to suggest a plausible explanation as to why teeth containing gangrenous pulps change color when air is admitted; also why a tooth containing a recently decomposed pulp is not discolored and does not readily change color until air is admitted. I fully recognize the fact that ferrous hydroxid is not the only compound of iron capable of producing color changes when moist and exposed to air. Nearly all of the ferrous compounds change more or less; but with the possible exception of ferrous carbonate, which could be formed, ferrous hydroxid is the only compound of iron possible to be produced, the color changes of which correspond to those seen in teeth which have reached the stage of permanent discoloration.

I have stated in this discussion that, in my opinion, it was also possible for ferrous sulphid to be formed ultimately by the putrefactive process; but it can only be produced by the hydrogen sulphid acting first upon the ammonia, forming ammonium sulphid, $H_2S + 2NH_3 = (NH_4)_2S$. This *alkaline* reagent will act upon the soluble salts of iron, precipitating the metal as ferrous sulphid. My conclusions, then, with reference to the true cause of the discoloration, are these: that the permanent yellow discoloration is due to the formation of ferric hydroxid; the bluish-black discoloration to a mixture of ferric hydroxid and ferrous sulphid—or to a failure of the ferrous hydroxid to become completely oxidized into the ferric form owing to a lack of moisture or oxygen; the other colors observed are transitory and are due to the gradual transition of the ferrous into the ferric hydroxid. In coming to these conclusions I have accepted the statement that iron plays the most important role of all the elements entering into the discoloration problem; for if it were possible to remove the hemoglobin from the blood or the iron from the hemoglobin, I do not believe the dentin could be discolored by any compound possible to be formed by the process of pulp decomposition. If this be true, my reasoning is at least logical.

Having thus far discussed the *cause* of the discoloration of tooth structure, the methods of restoring the normal color will now be considered.

Important Factors.—When a case presents for bleaching there are three important factors to be determined:

1. Ascertain, if possible, the cause of the discoloration.
2. Decide whether or not the color can be successfully restored.
3. The selection of the proper bleaching agent with which to restore the color.

The general cause of the discoloration can usually be ascertained from the history of the case as related by the patient. Whether or not the tooth can be successfully bleached depends largely upon the cause of the discoloration, the condition of the tooth-structure, and the length of time the tooth has been discolored. Experience will prove that the teeth which will permanently retain their color, after it is restored, are those that have a good bulk of dentin, which dentin can be protected by the remaining enamel and some filling material, preferably porcelain if this material is at all indicated. I desire to emphasize the fact that it is folly to expect a tooth to retain its color any length of time after once being bleached, unless *the dentin is properly protected*.

Having ascertained the cause of the discoloration and believing that the condition of the tooth-structure justifies us in attempting to bleach the tooth, we come to the most important consideration, viz., the selection of the bleaching agent with which the color can be restored with the least inconvenience to the patient and operator.

METHODS OF BLEACHING

All of the methods employed in bleaching teeth involve more or less chemistry and from a chemic viewpoint there are two general methods of bleaching teeth—*oxidation* and *reduction*.

I. **Oxidation.**—This general method is of two kinds also, *direct* and *indirect*.

1. *Direct.*—By direct oxidation is meant the use of any agent or agents from which oxygen can be directly obtained. The agents used for the purpose are:

Sodium dioxid, Na_2O_2.

Twenty-five per cent. ethereal solution of hydrogen dioxid, H_2O_2.

Alphozone, $(COOH.CH_2.CH_2CO)_2O_2$.

Acetozone, $C_6H_5CO.O.O.COCH_3$.

Aluminum chlorid, Al_2Cl_6, and a 3 per cent. aqueous solution of hydrogen dioxid, H_2O_2.

Oxalic acid, $H_2C_2O_4$.

2. *Indirect.*—By indirect oxidation is meant the use of any agent or agents by which oxygen can be obtained indirectly. The agents employed are such as will liberate nascent chlorin, Cl, a chemically active gas, which, in the presence of moistures, seizes upon a molecule of water, H_2O, abstracts the atoms of hydrogen, H, forming hydrochloric acid, HCl, and liberates the oxygen, O, in the nascent state, as $H_2O + 2Cl = 2HCl + O$ (nascent).

Some of the agents used for this purpose are:

Aluminum chlorid and a freshly prepared Labarraque's solution (Harlan).

Chlorinated lime and dilute acetic acid (Truman).

Powdered alum, $Al_2K_2(SO_4)_4$, and Labarraque's solution.

Solution of sodium chlorid electrically decomposed.

It will be remembered that certain precautions were mentioned in connection with the use of dichloramin-T and it was emphasized that this drug should not be employed in the treatment of wounds in aqueous solution—water causing decomposition with evolution of hydrochloric acid. The reason for this is explained in the above reaction; therefore, it may be observed that, under certain precau-

tions, dichloramin-T may prove a useful product from which chlorin is obtained and used in the indirect method of bleaching teeth.

II. **Reduction.**—By reduction is meant the use of any agent or agents which will abstract oxygen from a compound containing it. The agents which have been recommended are sodium sulphite, Na_2SO_3, 10 parts, and boric acid, H_3BO_3, 7 parts. These are mixed and placed within the tooth, moistened with water and hermetically sealed (Kirk). A reaction occurs between the two substances, with the ultimate formation of sulphurous acid which has a great affinity for oxygen and is, therefore, a good reducing agent. In some cases where the tooth has been discolored by remedial agents, and where it is desired to break up the color molecule, good results are obtained by this method. Whenever the method is used, the tooth should subsequently be thoroughly washed with an alkaline solution, such as a 10 per cent. solution of sodium bicarbonate or borax, to neutralize the acid.

In most cases of discoloration, the direct oxidation method is preferable; and, in view of the fact that all of the agents used in the indirect method of bleaching depend upon the generation of oxygen for their efficacy, it can readily be understood that the direct method is far more satisfactory. The fact, also, that hydrochloric acid is a constant by-product in the indirect method, thereby creating an *acid* medium, adds to the objectionable features of this method; for manufacturers have recognized for years that better results can be obtained in bleaching ivory, wool, hair, feathers, etc., when the bleaching process is carried on in an *alkaline* medium. This is likewise true in bleaching teeth. Believing, then, that the direct oxidation method is far superior to the indirect, I shall not burden my readers by describing the latter method, but will direct attention to the detailed use of sodium dioxid and 25 per cent. ethereal solution of hydrogen dioxid—both direct oxidizing agents, which, if their chemic properties are known and their dental application understood, the author believes to be the best agents for bleaching teeth thus far suggested to the profession.

Using Sodium Dioxid.—Sodium dioxid occurs in commerce as a yellow powder and is readily decomposed by water into caustic soda and oxygen. Because of this latter fact, much of the product obtained from wholesale druggists labeled "sodium dioxid," is nothing but caustic soda. This accounts for the fact that many dentists have tried this method of bleaching and failed to get results. The fault is not with the method, but with the powder used. In order that we

might be able to ascertain the efficacy of the chemical, some years ago I devised a simple chemic test for this purpose. In a clean, dry test-tube place about 15 gr. (1.0 Gm.) of the powder and to it add 30 min. (2.0 cc.) of water. If the specimen is good sodium dioxid, enough oxygen should be generated to kindle a glowing splinter held at the mouth of the tube. Having tested the chemical and proved it to be sodium dioxid, and not caustic soda, the next thing is to properly prepare the tooth, which, of course, should have been previously treated and the root filled with white gutta-percha.

Preparation of the Tooth.—The rubber dam should be adjusted, if possible, without the use of the steel clamp. The ligature should be wrapped twice around each tooth included in the dam, which should be at least two teeth on either side of the one to be bleached. This will prevent the by-product, caustic soda, from getting on the soft tissue and destroying it. The lower third of the root-filling should now be removed with a good-sized round bur—it being necessary, for permanent results, to bleach the tooth rootwise as far as possible. We are now ready to apply our bleaching agent.

Making the Application.—Both the dry sodium dioxid and a solution made by carefully dusting the powder into ice-water are recommended to be used. The best results are obtained by using the dry powder, placing it in the cavity and, with a platinum broach or pointed glass instrument, working the powder well up into the canal from which the root-filling has been removed. Care should be taken not to use steel instruments, as oxygen will attack the steel, forming ferric oxid, and, therefore, we may get into the tooth the pigment we are trying to remove. In some cases it is rather difficult to place the powder in the cavity without getting it on the patient's face or clothing. To overcome this a strip of unannealed 1 : 1,000 platinum foil can be placed between the discolored and adjacent tooth, letting it extend above or below the cutting-edge, as the case may be, when white base plate gutta-percha can be warmed and pressed against the lingual surfaces of the teeth included in the dam. This forms a pocket on the labial side within which the powder can be easily placed, using a little gold or platinum spoon or spatula. In more difficult cases a paste can be made of the powder and chloroform, in which it is insoluble, quickly packing the paste into the cavity, evaporating the chloroform, and leaving the dry powder where it is desired. Distilled water is now dropped upon the powder, causing a lively effervescence and the following reaction takes place:

$$Na_2O_2 + H_2O = 2NaOH + O \ (\textit{nascent}).$$

This nascent oxygen is a powerful oxidizing agent. It attacks and rapidly destroys any organic matter which may be present in the tubular structure of the dentin. It also thoroughly bleaches vegetable colors and acts upon any iron compounds which may have produced the discoloration. It converts ferric hydroxid, if present, into ferric oxid—still an insoluble compound. If ferrous sulphid is present in the moist state, it may be converted into ferrous sulphate, a soluble salt; but in the presence of caustic soda it would be reprecipitated as ferrous hydroxid, which, in turn, in the presence of oxygen, is at once reconverted into ferric oxid. Therefore, the pigment to be removed, if our chemic reasoning is correct as to the cause of the discoloration from pulp decomposition, is ferric oxid, an insoluble compound, and it must be removed mechanically by washing the tooth. Its removal is facilitated by the by-product, caustic soda, acting upon any fatty substances—fat being an end-product of the putrefaction of the proteid material—which may be present in the tubuli. The result of this action is a soluble soap, the removal of which by washing aids, as stated, the mechanical removal of the insoluble pigment.

It is the opinion of the author that the ultimate success depends quite as much upon the mechanical removal of the coloring matter as upon its chemic destruction, therefore the necessity of thoroughly washing the tooth after each application of the bleaching agent. Warm distilled water should be used in a strong syringe, letting a moist sponge absorb the water. The cavity is now dried, the color of the tooth observed and the process repeated, if necessary. Usually two or three applications are sufficient. If the color is not readily restored, the dentin can be saturated with a 2 per cent. solution of sulphuric acid which now enters the tubuli and chemically converts the oxids, that may not have been mechanically or otherwise removed by the saponifying and washing process, into sulphates. The salts produced are freely soluble, and can readily be washed out by again using the warm water.

Final Treatment.—When the tooth is satisfactorily bleached, a paste of precipitated calcium phosphate and distilled water can be placed in the cavity, packed into the lower third of the root and burnished, with a warm burnisher, against all exposed dentin. This is thoroughly dried by burnishing, the excess removed, and a light-colored, quick-setting cement used to form a base for the final filling.

Using 25 per cent. Ethereal Solution of Hydrogen Dioxid.—A 25 per cent. ethereal solution of hydrogen dioxid, called also caustic pyrozone, can be obtained in specially prepared and hermetically

sealed glass tubes. The date of its preparation is stamped upon the tube to guarantee its activity, for its value as a bleaching agent depends upon the volume of nascent oxygen which is liberated. It is, therefore, important that a good specimen of the agent be obtained. Care must be exercised in opening the tube, which should be wrapped in a cold, wet towel and held firmly in the left hand. With a *sharp* file make a groove around the pointed end of the tube, after which this end may be easily broken with a pair of pliers, the tube being pointed away from the face. A sharp file should be used, as a dull one might produce a spark and cause an explosion. When the tube is opened the contents should be transferred at once to a clean glass-stoppered bottle. The stopper should be sealed with paraffin when the remedy is not being used. In making the transfer, care should be taken to keep the agent from coming in contact with the fingers, as it readily cauterizes soft tissue.

Preparation of the Tooth.—The tooth should be prepared exactly as in using sodium dioxid, except that the cavity of the tooth should be moistened with an alkaline solution (10 per cent. solution of borax or sodium bicarbonate) before making the application. This is done in recognition of the fact that the bleaching process is more successful if carried on in an alkaline medium.

Making the Application.—There are some cavities within which it is difficult to place sodium dioxid, even if a paste has been made with chloroform, on account of the rapid evaporation of the latter. This is especially true where the cavity is small and in the lingual surface of one of the six upper anterior teeth. Teeth containing such cavities can usually be bleached more conveniently by using caustic pyrozone. The remedy can be applied in the canal loosely on cotton. To hasten the liberation of oxygen, a heated platinum wire can be gently placed on the cotton. The wire should not be too hot, as the heat may cause a flame from the ether in the solution. Heated dry air may also be used for the same purpose. After each application the tooth structure should be thoroughly washed with a warm alkaline solution, and the process repeated until the color is satisfactorily restored.

If, after repeating the application two or three times, the tooth is not satisfactorily bleached, the solution may be hermetically sealed in the cavity (see Fig. 145). If the cavity is small and on the lingual surface, the sealing can best be done by the use of gutta-percha (not temporary stopping). The excess of solution can be dried from the cavity and the hot gutta-percha applied, the heat of which hastens the liberation of oxygen which, together with the expansion of the confined ether, is carried into the entire tubular structure of the den-

tin. It is well to have the gutta-percha just flush with the margins of the cavity and then cover it with cement. By this means we are doubly certain that the remedy cannot escape. The final treatment is exactly the same as in using sodium dioxid.

Caustic pyrozone is a very escharotic agent, and equally as much care should be taken to prevent the remedy from coming in contact with the soft tissues of the mouth or the fingers of the operator as in using sodium dioxid. The remedy being in liquid form is more easily handled than the sodium dioxid powder.

FIG. 145.—This is the case of a young lady, about 17 years of age, who met with an accident in which the maxilla was fractured, loosening the central and lateral incisors. The fracture was reduced by Dr. W. H. G. Logan. About one year later the central began to discolor slightly, when patient was referred. The tooth was opened on Dec. 29, 1914, and the pulp was found to be dying, though not completely dead. Formocresol was sealed in contact with the tissue. On Jan. 4, 1915, the pulp was removed and phenolsulphonic acid was employed. Phenol compound was sealed in the canal. The root-filling operation was performed on Jan. 7, and the color restored by sealing caustic pyrozone in the canal; after which a lingual filling was inserted. The radiogram was taken April 1, 1916, about fifteen months after the root-filling operation. The color of the tooth at this time was perfectly normal. Notice that there is no periapical involvement.

The other direct oxidizing agents are used in practically the same way. The alphozone and acetozone powder can be placed in the cavity, moistened with an alkaline solution and hermetically seaead. The volume of oxygen liberated from these agents is not great, and the process of bleaching, therefore, is much slower than when sodium dioxid or caustic pyrozone is used.

In conclusion, I desire to say that in the bleaching of teeth we find a practical application of the science of chemistry to the practice of dentistry, and that in the discoloration of tooth-structure from the various sources can be found a fruitful field for further investigation.

ANTRUM OF HIGHMORE

GENERAL CONSIDERATIONS

The antrum of Highmore, or maxillary sinus, is a chamber or cavity in the body of the superior maxillary bone on either side of the jaw. It should be remembered in connection with the therapeutics of the diseases of the antrum that the cavity is normally lined with mucous membrane, which is continuous from the nasal cavity through a small opening, called the ostium maxillare; that the cavity varies in location and size, and is capable of containing from two drams (8.0 cc.) to, sometimes, one ounce (30.0 cc.) of fluid. Fortunately, the dentist, in general practice, is not often called upon to treat diseases of the maxillary sinus, but when a case presents of purely dental origin, he should be prepared to make a correct diagnosis and to properly treat the case. (See Figs. 146 and 147.)

Causes of Diseases of the Antrum.—There are many contributing causes of disease of the maxillary antrum, among the more important of which are:

1. *Dental Conditions.*—It was formerly quite generally conceded by both rhinologists and dentists that the teeth, or conditions associated with the teeth, are the greatest source from which the membrane lining the chamber may become irritated to the extent of bringing about a degeneration of the cells, when infection is liable to occur and pus result. Cryer, Logan and others, however, have not found the teeth as the primary cause to the extent as was heretofore supposed. It has been previously mentioned that one of the serious complications of alveolar abscesses is where the pus is evacuated into the antral cavity, instead of working its way through the labial or buccal, and sometimes through the lingual plate of bone emptying into the mouth, as is the case usually. (See Fig. 99.) The author reports here two cases in the College Infirmary where a student had removed a vital pulp and entered the antrum through the canal, showing that all that separated the end of the root from the floor of the antrum was the mucoperiosteum, which the student penetrated. One case was the lingual canal of a first molar, and the other the canal of a second bicuspid. Other cases of this character have since been observed in the College clinic. If abscesses occur in connection with teeth thus situated in the jaw, the antrum will at once become involved.

FIG. 146.—Antero-posterior division through the maxillary sinus. (*Cryer.*)

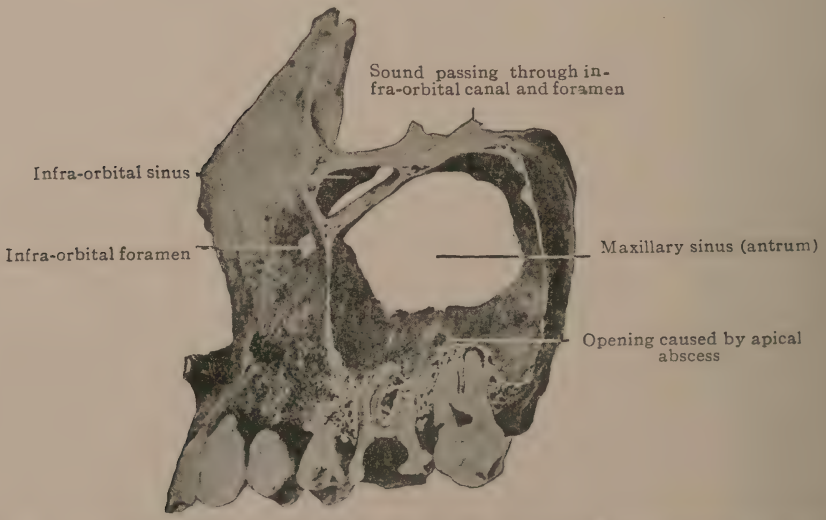

FIG. 147.—Vertical transverse section showing the close relation of the roots of the molar teeth to the maxillary sinus (antrum). (*Cryer, Dental Cosmos.*)

2. *Catarrhal Inflammation.*—Since the Schneiderian membrane which lines the nasal cavity passes through the ostium maxillare and the continuation of it lines the antral cavity, any inflammation of the nasal mucous membrane, if continuous and progressive, may involve the antrum. Especially is this true of patients who have catarrh, influenza, or grip. Even an acute coryza may seriously involve the antrum.

3. *Foreign Material.*—Foreign material constitutes another prolific source of disease of the antrum. Teeth, especially third molars, have been known to erupt into the antrum; dentigerous cysts and polypi are frequently found; and, occasionally, in the careless extraction of a pointed root, and even at times when due care and judgment are exercised, if the root is badly decayed, it may be forced by the forceps into the antral cavity.

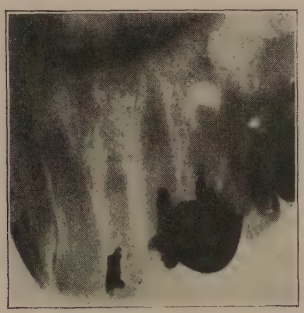

FIG. 148.—This radiogram shows a case of suspected antral involvement. There was no external discharge of pus, but severe neuralgia and some of the other subjective symptoms of antral disease. The cuspid and first bicuspid, on the affected side, carried artificial crowns. The radiogram would indicate that the antrum is not involved, but shows that the canal of the cuspid root is not filled. This canal was found to be gangrenous; also a necrotic area about the apical end of the imperfectly filled first bicuspid root is disclosed by the radiogram.

4. *Traumatism.*—The antrum frequently becomes involved as a result of some traumatic injury, such as a blow, etc.

It is frequently difficult to make a correct and positive diagnosis of antral disease. The symptoms generally are of the subjective variety, unless the cause is some traumatic injury, in which case the diagnosis is readily made.

Diagnosis.—The symptoms which aid in arriving at a diagnosis are: A sense of fullness on the affected side; at times the pressure may be so great as to cause the eye to distend from its orbit; frequently an odor and discharge of bloody pus or mucus through the nose, especially when the patient coughs or sneezes, or when he lies in a certain position. The use of the *x*-ray and the little electric mouth-lamp

(Cameron lamp), while by no means positive, are invaluable aids in making the diagnosis (see Fig. 148). By pulling down the shades, making the room as dark as possible, and placing the electric mouth-lamp on the lingual side of the teeth a dead pulp may be detected which is causing the trouble. Placing the lamp higher in the vault, the antrum, if diseased, will generally present a more cloudy or foggy appearance than will the healthy antrum. After making the diagnosis, the next important step is to decide on the method of treatment. If no dental condition seems to be causing the disease, the patient should be referred to a rhinologist for further examination; but if the diseased condition of the antrum is of dental origin, it is the prerogative of the dentist to treat the case, if he so desires.

THERAPEUTICS

The treatment is of two kinds—*surgical* and *medicinal*.

1. Surgical Treatment.—The surgical treatment of diseases of the antrum will be discussed here but briefly. To intelligently treat the condition it is, of course, essential to find the cause and remove it. Let it be understood that this does not necessarily mean that if the cause of the antral trouble is an abscessed tooth, it is necessary to extract the tooth. Frequently, by treating the affected tooth and opening into the antrum and washing out the cavity, the case will yield nicely. Whether it is necessary to extract the offending tooth is often a difficult problem to solve. Many teeth have been needlessly sacrificed in the surgical treatment of diseases of the maxillary antrum, especially by the general surgeon; while, on the other hand, many antrums have become chronically diseased, which condition might have been avoided and the case cured during its incipiency, had it not been for the presumable conservativeness of dentists, especially, in their efforts to cure the antral disease and at the same time save the tooth. It should be remembered that *important as every tooth is—a healthy antrum is of greater importance.* In making this statement the author does not mean to encourage the needless extraction of teeth in connection with the surgical treatment.

The site of making the opening depends upon the conditions as found. Probably no two cases will need exactly the same kind of opening. It may be made through a tooth-socket, just posterior to the canine fossa, between the roots of teeth, or through the nose. The latter opening should be made by a rhinologist, if necessary. The tendency at first is to make the opening too small rather than large enough. In many cases it is necessary to have the opening sufficiently large to permit an ocular or digital examination. A

thorough examination at this stage of the operation will determine whether the cavity needs curettement or simply the establishment of drainage and evacuation of the pus or mucoserous fluid.

It is seldom necessary to administer a general anesthetic other than nitrous oxid and oxygen for the purpose of opening into the antrum painlessly. It may be accomplished in most cases practically without pain by the use of local anesthetics; especially is this true since conduction anesthesia is used so generally. Where extensive curettement is indicated, a general anesthetic had better be given. Nitrous oxid and oxygen serves the purpose admirably. We now come to the phase of the subject of most interest from *our* point of view—the *therapeutics*. Before discussing the drugs used in treating diseases of the antrum of Highmore, I desire to emphasize the fact that it matters little what drugs are used as long as they are practically nonirritating and antiseptic, if the surgical treatment has been all that is required. If the cause has not been surgically removed or corrected, drugs will be of little avail; for this reason the surgical treatment has been discussed here briefly.

2. Medicinal Treatment.—The therapeutics of the condition under consideration consists in washing the antral cavity with bland remedies for the purpose of disposing of the pus and mucoserous fluid; this to be followed by antiseptic and stimulating remedies. Any bland solution may be used which is nonirritating and antiseptic, provided the odor and taste of the agent employed are not objectionable. A warm saturated solution of boric acid serves the purpose admirably. The author, however, prefers using a warm sterile physiologic salt solution. These solutions may be used in a fountain syringe, the latter being placed on the wall as high as convenient so that considerable force may be exerted in the washing process. A glass or hard rubber point should be attached to the rubber tubing, and should be of such shape and size as to pass easily into the opening. The escape of fluid from the syringe should be controlled by a stop-cock. By this means the cavity can be well flushed out, using a considerable quantity of fluid. In the absence of a fountain syringe, a strong water syringe may be used. The physiologic saline solution also acts as a stimulant to the mucous membrane. After thoroughly washing the cavity, most of the solution which naturally remains can be absorbed with cotton and the cavity injected full of some antiseptic and stimulating remedy. Brophy recommends argyrol, using all the way from a 10 to a 50 per cent. solution; and in recent years a solution of dichloramin-T (5 per cent.) has been employed. Free drainage must be established when the latter solution is used.

Beck suggests using bismuth paste. This has the distinct advantage of completely filling the space with a semi-solid, oleaginous paste, which guards against septic invasion from the mouth, and at the same time holds the stimulating drug in contact with the entire membrane of the cavity. Some care must be exercised in making the injection so as not to force the paste into communicating sinuses. The injection may be repeated as often as the necessity of the case demands. If there be no complication, two or three injections, at intervals of two or three days, will generally suffice. The author prefers using antiseptic and stimulating solutions, like 25 per cent. argyrol, 5 per cent. dichloramin-T, or 1 or 2 per cent. iodin, rather than bismuth paste.

There is little necessity for using strong disinfectant or cauterizing agents in the medicinal treatment of diseases of the maxillary sinus. If the case does not yield to the treatment here given, some complication may be suspected, for which see works on Oral Surgery.

PERIODONTOCLASIA

(Pyorrhea Alveolaris)

GENERAL CONSIDERATIONS

Because of the customary use of the term, and for want of a better one, this much-named disease, in previous editions, has been called throughout this work *pyorrhea alveolaris*. The Committee on Dental Nomenclature of the American Dental Association, in its recent report, has adopted the word *periodontoclasia*, with which the author is in full accord; therefore, the latter term will be used in this edition. However, in the descriptive text it will be necessary to use frequently the adjective "pyorrheal" to designate certain remedies and conditions.

It has been elsewhere mentioned that there are two types of chronic infection in the mouth—alveolar abscess and periodontoclasia.

Generally speaking, periodontoclasia may be considered a chronic suppurative disease of the supporting or investing tissues of the teeth (gums, pericementum and alveolar process)—a destructive degeneration of the tissues about the root of a tooth, progressing insidiously with occasional acute exacerbations. The disease begins as an interstitial gingivitis; the gum septum first becomes reddened, then swollen and tender and bleeds easily. The swollen gum frequently assumes a deep red or purple color and forms spongy festoons between the affected teeth (see Fig. 150 p. 506).

The true pathology and etiology of this disease is yet an unsolved problem, notwithstanding the fact that its solution, for years, has been attempted by the most scientific men of the profession. In recent years, the disease has engaged the attention of the medical as well as the dental profession; for it is now well recognized that, whether or not the disease is of purely local origin or is a local manifestation of some constitutional disorder, its presence in the mouth is the forerunner of many grave systemic diseases.

Probable Causes.—The causes of periodontoclasia may be grouped into two classes: *predisposing* and *active*.

The conditions which predispose to the disease are many and varied, and include the following: Faulty occlusion, irregular teeth, faulty or no contacts between teeth, ill-fitting crowns, bridges

and partial dentures, calcific deposits, bacterial plaques, certain drug poisons (mercury), certain constitutional diseases, etc.

The active or exciting cause of the disease is a pathogenic microorganism of some kind. In the past many organisms have been credited with being the specific cause of periodontoclasia. A bacteriologic examination of the pus from a pyorrheal pocket will disclose a vast number of bacteria. The difficulty is to ascertain, with any degree of certainty, which organism is pathogenic in the case. The work of Barrett and Smith,[1] of Philadelphia, corroborated by that of Bass and Johns,[2] of New Orleans, was thought for a time to prove rather conclusively that the causative agent is not a bacterial organism, but a protozöön—the *Endameba buccalis*, and perhaps other species of endamebæ. Very little, if any, attention is paid to this supposition today.

After making hundreds of smears, Hartzell,[3] of Minneapolis, found the *streptococcus viridans* and the *fusiform bacillus* and its accompanying *spirocheta* universally present in all pyorrheal pockets and on tooth surfaces. This author concludes by saying, "The finding by culture of viridans below the level of attachment in the membrane also impresses us with the thought that streptococci are the principal organisms of periodontoclasia and that amebæ and all other germs are contributing factors only." Brook,[4] of London, England, and others, have also found the streptococcus family to be the predominating organism in infections about the teeth.

Whether the endamebæ or the streptococci viridans or other bacteria are the specific cause will not be discussed further here. Enough has been introduced to show that the true pathology and etiology of periodontoclasia are still unsolved problems. The effects of the disease upon the system will now engage our attention.

Systemic Effects.—The systemic effects of periodontoclasia may result in two ways, as pointed out by Brook: (1) By the absorption of toxins and germs locally, through the infected gums and alveolar process, or, (2) by the absorption of toxins after the bacteria have entered the gastrointestinal tract, either from the stomach or intestines. This author points out the fallacy of the too common belief that the gastric secretion is sufficiently antiseptic to kill all of the bacteria reaching the stomach from the mouth; for

[1] Dental Cosmos, 1914.
[2] Journal American Medical Association, Feb. 13, 1915.
[3] Dental Review, Sept., 1915.
[4] Dental Review, June, 1915.

he states that the same type of streptococcus found in the pyorrheal pus can be also isolated in many cases from the feces in persons suffering from the disease. It is also mentioned that a very limited amount of infection in the mouth may give rise to a great deal of systemic toxemia, owing to the fact that the bacteria multiply at such a great rate, one producing many millions in twenty-four hours, so that even a trivial amount of oral infection may mean an enormous number of pathogenic bacteria by the time the intestinal contents are evacuated from the bowel.

While it is possible, as stated, that absorption of toxins and germs may take place locally through the infected gums and alveolar process, there can be little doubt that the absorption of toxins from the gastrointestinal tract is of far greater significance. Logan[1] has repeatedly shown that the blood count in cases of periodontoclasia gives very little evidence of infection unless the pocket is deep, extending to or nearly to the root apex and involving the alveolar process. Carmichael[2] expresses the opinion that for the bacteria and toxins to be absorbed locally, it is essential that the pressure within the infected area shall exceed the pressure within the blood-vessels themselves; and this author concludes that inasmuch as the pyorrheal pocket in the vast majority of cases is in open and direct communication with the oral cavity by means of an external sinus, the toxic bacterial products liberated in the pocket are far more frequently emptied into the mouth, finding their way into the gastrointestinal tract, rather than gaining direct entrance into the circulation. This theory would seem to prove the correctness of Logan's observations; though the latter author does not base his findings on such a theory, nor does it harmonize with the statement of bacteriologists to the effect that certain poisons known as *xtracellular toxins* are excreted by the bacteria directly into the tissues or blood-stream. The toxins excreted by the streptococcus viridans are extracellular. (See Biologic Products, p. 270.)

With this knowledge before us, it will be interesting to trace the pus, containing the bacteria and toxins, in its course after it leaves the pyorrheal pocket, and to learn the diseases which may, and frequently do, result therefrom. This has been well done by Brook, from which author I here quote: "The pus passes first into the mouth, where it may give rise to ulcerative stomatitis, mixing here with the saliva, it flows first over the tonsils, which it may infect with the result of acute tonsillitis and quinsy. It then passes into the pharynx

[1] Various Journal articles.

[2] Dental Review, August, 1915.

and then the esophagus, where it may cause pharyngitis and esophagitis. Should any be drawn into the trachea and bronchi it may produce bronchitis, acute and chronic, and gravest of them all—pneumonia or bronchopneumonia; passing down the esophagus it next enters the stomach. Chronic indigestion is by far the commonest sequela here, but another very grave trouble may result—gastric ulcer.[1] In the small intestine, it causes chronic intestinal indigestion, and flatulence, and may infect the bile duct, giving jaundice and gall-stones, etc. It then enters the cecum and the appendix. Passing on into the colon, we come to the subject of colitis. This disease is much more prevalent than is commonly thought. It is marked by diarrhea, more or less spasmodic, and the passage of mucus in the stools. In acute cases, blood in more or less large quantities may be passed. In the chronic cases, chronic abdominal pain often amounting to colic, diarrhea, unformed stools, or occasional constipation, local abdominal tenderness, flatulence, and distention result." In connection with appendicitis, this author emphatically states his view that a large majority of cases are due to periodontoclasia and nothing else. Most of the cases, if examined, show symptoms of the disease, often of old standing, and then the same bacterium, streptococcus pyogenes longus, can be isolated from the pyorrheal pocket and from the appendicular abscess. This means, according to Brook, that had the patient been cured of this periodontoclasia before his appendix became infected he would never have had the attack of appendicitis which brought him into the hands of the physician and, perhaps, surgeon.

So far as the treatment of periodontoclasia is concerned, the author is of the opinion that a mistake has been made by the profession generally in grouping all of the disorders commonly called periodontoclasia under one heading and endeavoring to effect a cure of the entire group by a common treatment. It is true that the treatment of the various diseases affecting the gum, pericemental, and alveolar tissues have many things in common, yet the correct treatment must necessarily involve special measures to meet the demands of a given case. Therefore, for convenience in outlining our treatment the various disorders so commonly grouped in the past under the heading of periodontoclasia will be arbitrarily divided into three classes. It must be understood, however, that in reality no dis-

[1] This complication has been pointed out by Sir Bertrand Dawson, of England, and supposedly quite conclusively proven by Rosenow, of the Mayo Clinic, Rochester, Minn. Miloslavich, Pathologists of Milwaukee, Wis., does not agree with Rosenow's findings.

tinct line of demarcation can be drawn. The division is made purely for convenience in studying the disease from the therapeutic point of view.

DESCRIPTION OF CLASSES

Class I.—This class includes such cases as often present where upon examination it will be noticed that around several teeth in the mouth, just under the free margin of the gum, there is a hard, dark, flint-like, annular deposit, which in some instances nearly and oftentimes completely encircles the tooth. This deposit comes from the blood, and is known as *serumal calculus*. It is caused by some local irritant at the gum margin, generally oral filth and bacteria, which results in gingivitis—always a characteristic symptom of this class.

FIG. 149.—This shows the extent to which salivary calculus will form on the roots of the lower anterior teeth in some mouths, if neglected. The crown is nearly covered as is also most of the root—only a small portion near the apex being free from deposit.

There may or may not be pus, generally there is not; the pockets, if any, are shallow. It will usually be noticed that there is more or less *salivary deposit* on the lingual surfaces of the lower anterior teeth and on the buccal surfaces of the upper first and second molars. The general condition of the mouth gives every evidence of neglect, which may be considered the cause of this class of periodontoclasia. Fig. 149 shows the extent to which salivary deposits may accumulate in a neglected mouth. Fig. 152 shows the results which frequently follow faulty occlusion.

Class II.—This class is what might properly be called true periodontoclasia. In it will be considered those aggravated cases wherein there is little evidence of gingivitis; the gum, in fact, appears anemic rather than hyperemic, and is gradually receding from the neck of the tooth. The pericemental membrane is being rapidly destroyed; the alveolar process is resorbed—virtually melting away; the pockets are deep and variously located around the single root of

a tooth, and oftentimes between the roots of multi-rooted teeth. Pus is generally present, and there may or may not be hard deposits. Unless the disease is checked, there is a progressive loosening of the teeth, to the extent that they ultimately drop out. The cause of this class is unknown. It may be a bacterium, but as yet no specific germ has been satisfactorily demonstrated to be the exciting agent, though the presence of various pathogenic germs has been scientifically proven, as is evidenced also clinically by the pus formation. Surely the cause cannot be neglect on the part of the patient, for the disease occurs and often persists in the mouths of patients who are scrupulously clean so far as the toilet of the mouth is concerned. These are the cases where the diet should be carefully checked (see Food and Diet, page 278). The cause in far too many instances can rather be traced to neglect on the part of the family dentist, who either failed to recognize and cure the disease in its incipiency,

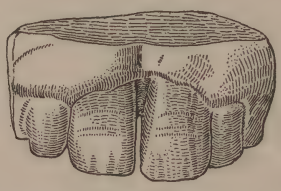

FIG. 150.—This shows the recession of gum tissue due to the resorption of the alveolar process between the central incisors—the result of peridontoclasia.

or, recognizing it, informed the patient that nothing at all could be done and advised letting it go, ultimately extracting the teeth. It is sadly to be regretted that so many teeth have been needlessly lost in the past because of the seeming indifference of dentists; but the study of diet and the wave of prophylaxis that has been floating over the profession in recent years, due to the efforts of many investigators is an encouraging sign that individual dentists are either equipping themselves to combat the disease or are referring the patients thus afflicted to dentists who are so equipped. Fig. 150 illustrates a typical case of this class.

Class III.—In this class will be considered those cases in which we are reasonably certain that the local condition in the mouth is at least aggravated by, if not entirely due to, some systemic derangement. It has been quite clearly demonstrated by Pierce, Rhein, Talbot, Kirk, Fletcher, Endelman and others, that at least certain kinds of periodontoclasia are closely associated with, if not caused by, such general diseases and conditions as syphilis, tuberculosis, actinomycosis, diabetes, osteomyelitis, salivation, phosphor poisoning,

FIG. 151.—The picture of the model on the left shows a typical case of Class I, involving both central and one lateral incisors. The picture of the model on the right shows a pyorrheal case which has been treated and cured. The central was treated by the author in 1904, the cuspid in 1915. The case being a referred one, I did not see the patient from the time the pocket along the labial of the central was cured until the cuspid became involved. The results here emphasize the advisability of surgically eliminating the pocket whenever indicated.

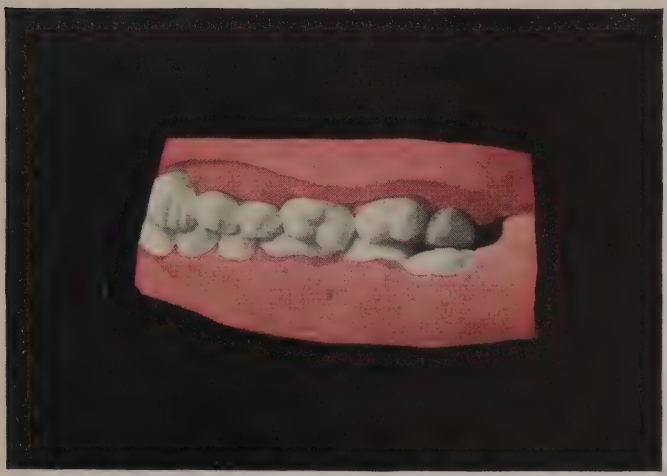

FIG. 152.—This picture is from a model taken of a case where the upper third molar prevented the lower third molar from fully erupting. A food pocket formed between the upper second and third molars, causing the third to decay. Frequently pyorrheal pockets form from just such conditions. Where the third molars are the teeth in volved, it is generally best to extract the tooth, as was done in this case. The upper third molar shown in the picture is the actual tooth extracted. It was placed in the impression, and the model made.

malnutrition, and faulty metabolism in general. The symptoms here are variable, and depend largely upon the general complication. In such diseases as syphilis, tuberculosis, actinomycosis, and osteomyelitis, the alveolar process is extensively involved and usually rapidly resorbed, the teeth are loosened, there is generally an absence of hard deposits, the pus is persistent, and recovery is much slower than usual. In diabetes the gums are often turgid and raw, the pericemental membrane is inflamed and highly sensitive, there is a tendency toward the formation of serumal deposits, and pus may or may not be present. The mouth symptoms of salivation or mercurial stomatitis and phosphor poisoning have been elsewhere described. In faulty metabolism the symptoms are variable, and none has been demonstrated to be truly characteristic of the general condition. Periodontoclasia was formerly thought by certain investigators to be caused by gout or what was known as the "rheumatic diathesis." To-day it has been definitely proven that rheumatism (arthritis) is due to an infection, and the foci of infection has frequently been traced to deep pyorrheal pockets about the teeth.

With this understanding of the conditions which present in the various classes of the disease under consideration, we will now discuss the treatment.

THERAPEUTICS

When cases of periodontoclasia present for treatment, the first important consideration is to impress upon the minds of the patients the fact that you must have their hearty cooperation, and that in order to obtain permanent results it will be necessary for them to follow your instructions closely. There is, perhaps, no condition which dentists are called upon to treat wherein the confidence, and especially the cooperation of the patient is of such vital importance, so far as permanent results are concerned, as in the treatment of true periodontoclasia; and it is truly surprising what good results can be accomplished by the conscientious and persistent efforts of both dentist and patient.

Before undertaking the treatment of a case, then, there should be a distinct understanding as to what may reasonably be expected. The discerning patients will, naturally, want to know at the outset if their cases can be *cured*. The word "cure" here is but a relative term, and an explanation should be made in regard to what a so-called cure includes. It does not mean that the lost tissues—gum, pericemental, and alveolar—can be restored. It should mean, how-

ever, that the teeth treated can ultimately be made healthy, comfortable, and useful, so far as mastication is concerned. Any tooth which we cannot reasonably expect to restore to this condition had better be considered a hopeless tooth and extracted at once, and there are many such in the mouths of pyorrheal patients.

As has been elsewhere explained, while the presence of pus which is constantly being mixed and swallowed with the saliva and food is of greater importance, so far as health is concerned, than is the looseness of the teeth in the jaw, patients, until recently, were more interested in the latter phase of the question; and they are always anxious to know whether the now loosened teeth will become firmly fixed in the jaw after the treatment. This all depends upon the case at hand and the mechanical treatment involved. In the past too much dependence has been placed in drugs, and too much also has been left to Nature to tighten the teeth, when this should not have been expected on account of the extensive loss of the supporting or investing tissues; and the conscientious dentist who makes extravagant statements in this respect will cause much disappointment to both himself and to the patient. It is surprising, at times, how loosened pyorrheal teeth will tighten in the jaw under proper treatment without mechanical assistance, but too much should not be promised in this respect (Fig. 153). The author desires to speak plainly on this point, for herein often lies the greatest source of disappointment. Unless the end of the root is resorbed, leaving it roughened, the pus formation can be checked, the gum can be made to resume a healthy appearance, but many times the teeth, without mechanical aid, will not materially tighten, though otherwise they are perfectly healthy and comfortable. Their usefulness, of course, is impaired on account of their being loose.

A thorough understanding at the beginning of the treatment, then, serves as a means of stimulating *confidence* on the part of the patient in the operator's ability to meet the conditions as found and the conscientiousness with which he works. No dentist should undertake the treatment of a case of true periodontoclasia unless he is equipped to render the best possible service, considering always the personal equation, and then only with the understanding that both he and the patient are to work in harmony—each exerting their best efforts to eradicate the disease. It is far better not to undertake the treatment of a case than to have it end in disappointment.

The detailed treatment of the three classes into which the disorders commonly called periodontoclasia have been divided will be considered separately, for herein lies the value of making the

FIG. 153.—This picture is of a model taken of a case after being cured of periodontoclasia. Notice the second bicuspid which was badly affected and loose, but is now firm and comfortable.

subdivisions. The treatment is of three kinds—*surgical*, *medicinal*, and *mechanical*.

CLASS I

1. Surgical Treatment.—In this class, it will be remembered, deposits are always in evidence. The first step in the treatment is to *remove the deposits*. This is accomplished by instrumentation, care being taken to remove the irritant material without undue injury to gum, pericementum, and tooth-structures. The instruments which the author uses for this purpose are the Logan-Buckley set, illustrations and brief descriptions of which are found in Fig. 154. Another very excellent set of instruments is known as the Carr set. By the use of either of these sets of instruments the deposits can be removed with a minimum amount of injury to the structures involved. MaWhinney has especially emphasized the injury done to the so-called dental ligament and the other soft tissues by careless instrumentation, and Patterson, James, Hartzell, and others have demonstrated the fact that better results are obtained when the deposits are removed in such a manner as to leave the tooth-surface smooth and easily polished. Extreme care should always be taken in removing hard deposits from the necks of teeth to avoid having the deposit when loosened fly in the eye of the operator or patient. Several cases are on record where the dentist's eye became seriously infected, and in a few cases the sight was lost by such an accident.

Before beginning the scaling process the mouth should be thoroughly sprayed or rinsed with an antiseptic solution. For this purpose the author uses cinnamon water to which about 2 per cent. of alcohol is added. The cinnamon water is an agreeable solution, and the alcohol aids in removing the mucoid material with which the teeth in this class of cases are generally coated. A glassful of the cinnamon water should also be in a convenient place. This solution can be colored pink or a reddish tinge by adding a small amount of tincture of cudbear. The object in having the solution colored is to prevent the patient from seeing the blood which is always more or less in evidence in scaling these teeth on account of the gingivitis—a characteristic symptom of this class. The solution is used with a strong water syringe as often as is necessary to clear the field of operation. The scaling should be begun on some certain tooth in the mouth and this should not be left until it is thoroughly scaled. This can only be done with any degree of certainty by following some defi-

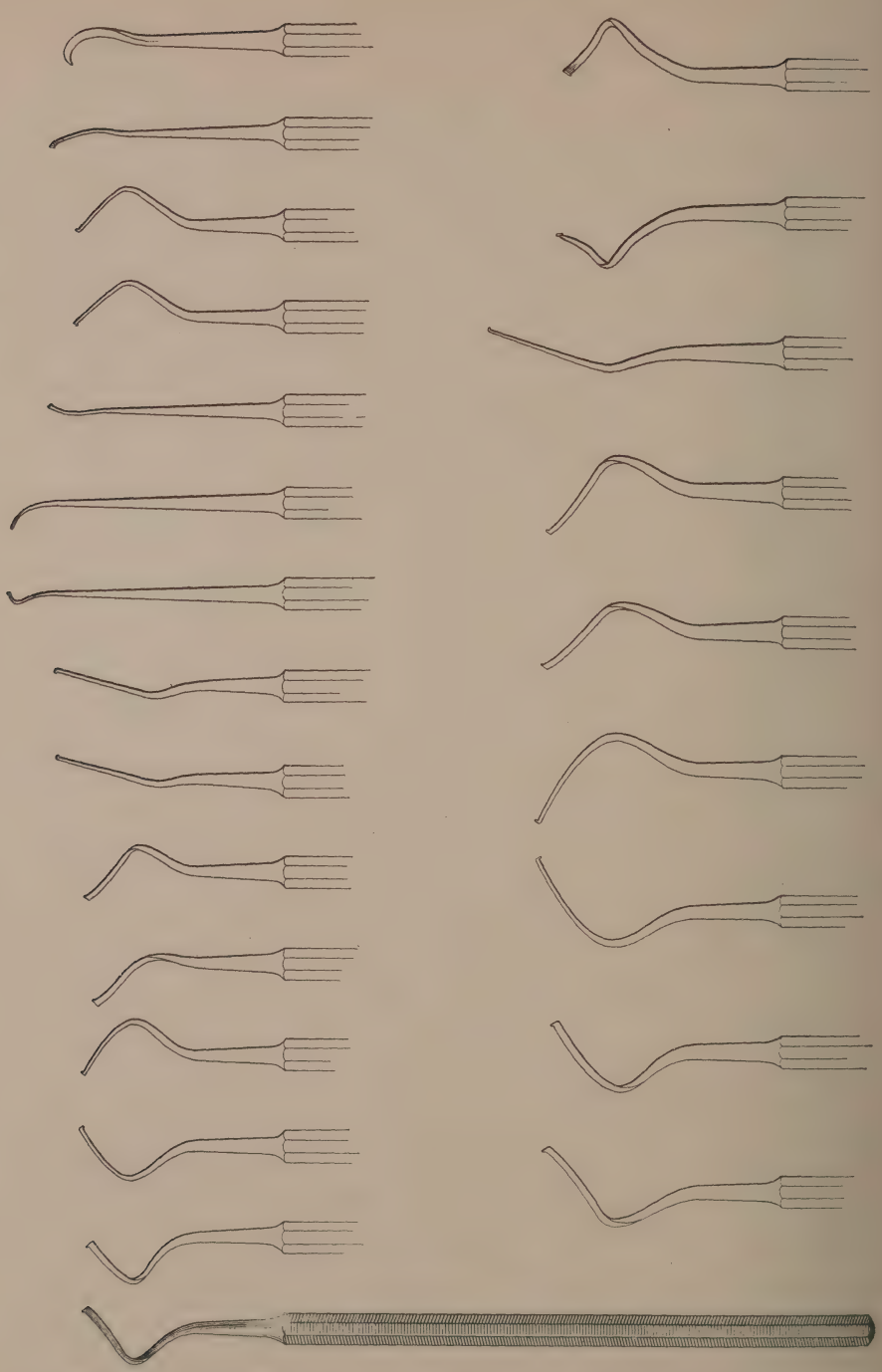

FIG. 154.—Logan-Buckley set of pyorrheal and prophylactic instruments. For description of their uses, see next page.

nite system. By using either of the sets of instruments mentioned, the scaling can be done systematically. With the L.-B. set, the author begins on the mesiobuccal surface of the upper third molar, and with the six instruments designed for the purpose one can work completely around the tooth in an intelligent manner. From here we can proceed from one tooth to another around the arch, using the instruments designed for the various surfaces. If there be a bulky deposit, such, for instance, as salivary deposits, this should be removed first with the hook instrument designed especially for this purpose.

After an instrument has been used the point, at least, should be kept immersed in an antiseptic solution during the entire time the scaling is being done. This can best be done by having a tray which is designed to hold the instruments in their proper places. Such a tray with the entire L.-B. set of instruments in their proper places is illustrated in Figs. 155 and 156.

The instruments are presumed to be sterile before they are used; it is, therefore, unnecessary to have a strong disinfecting solution in the tray. Such a solution would either act upon the instruments or taste badly when the instrument is placed in the patient's mouth, for the necessary instrument should be taken directly from the rack of the tray and used in the mouth. A pleasant antiseptic solution, therefore, should be in the tray. It is a principle in surgery to avoid the presence of germs by having the instruments sterile before using

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BRIEF DESCRIPTION OF HOW TO USE THE LOGAN-BUCKLEY SET OF INSTRUMENTS

These instruments are so designed that the teeth may be scaled systematically. Beginning on the mesiobuccal surface of an upper molar or bicuspid tooth, the instruments are used as follows: No. 1 for the mesiobuccal, No. 2 for the buccal, No. 3 for the distobuccal, No. 4 for the distolingual, No. 5 for the lingual, and No. 6 for the mesiolingual surface. These six instruments, therefore, scale systematically around the tooth. If at any point a pocket is found too deep to be reached with these instruments, their counterparts, except with a narrower point and exaggerated in form, are found in Nos. 16 to 21 inclusive. For example, No. 16 is the exaggerated form of No. 1, and so on with the entire six instruments. For the lower teeth the positions of the instruments are exactly reversed, *i.e.*, Nos. 1 and 16 are here used on the mesiolingual surface, etc. With one or the other of these groups of six instruments the molar and bicuspid teeth can be scaled, except, occasionally, where deep pockets are found between the roots of molar teeth and on the lingual surface of the divergent lingual root of upper molars. For these exceptional cases, Nos. 9 and 10 are right and left and are employed for scaling between the roots of molars, and Nos. 24 and 25 are right and left for the lingual surface of a divergent lingual root of upper molars. No. 23 is for the distal surfaces of posterior teeth (third molars).

For the anterior teeth, upper and lower, No. 7 is designed for the lingual surfaces, and No. 8 for the labial. In cases where there is a deep lingual pocket which cannot be reached with No. 7, No. 22, the exaggerated form, can be used. No. 11 is a push instrument used in removing deposit from between crowded and irregular teeth. No. 15 is a general hook for removing the bulky deposit before the more delicate instruments are used. Nos. 12, 13, and 14 are prophylactic instruments which can be used with either a push or pull movement and will be found useful in removing superficial decay and in smoothing and polishing rough surfaces.

rather than to endeavor to kill the germs by the use of strong disinfectants during the operation. The author uses a 20 per cent. solution of phenol compound in glycerin, and of this about 10 min. (0.6 cc.) is

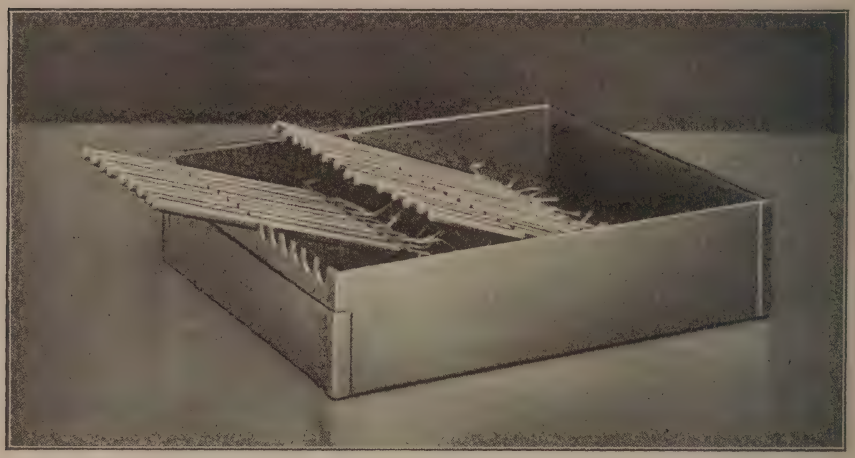

FIG. 155.—This shows the instruments in their proper places in the tray ready for use.

added to about ½ pint (240.0 cc.) of sterile water, which is in the tray. This solution can also be colored with tincture of cudbear to conceal the blood.

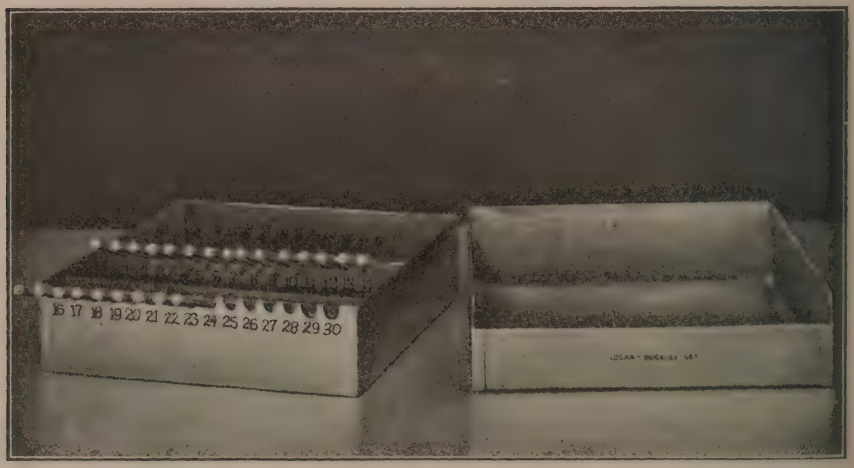

FIG. 156.—This shows how the inner rack can be removed for the purpose of sterilization.

The pockets here, if any, are not deep; the deposits are readily removed, and a number of teeth may be scaled at one sitting. Unless there be some good reason for extending the length of time of the operation, it should be limited to one hour, and the scaling process

should be stopped in sufficient time to permit a thorough prophylactic treatment with Arkansas and carborundum stones, orange wood, pumice, and tape, according to the method of D. D. Smith, before applying the medicinal treatment. The teeth here are not loose and, therefore, they need no mechanical support. A record should be kept of the teeth treated at each sitting, so that we may know exactly where to begin when the patient returns. Hartzell[1] advises the prophylactic treatment before undertaking the root surgery. On this point he says: "Experience has taught us that the logical place to begin the treatment of periodontoclasia is the tooth's surface and that the first step in the treatment of any pyorrheal case is to demonstrate to the patient and to the operator the relative amount of bacterial growth on the tooth's surface. This is important to both—important to the patient because it directs his attention to those areas of the tooth's surface which need the greatest daily care, and important to the operator because it explains to him the reason for gingival inflammation where oftentimes no other rational cause can be found. These areas may be shown by using 'disclosing solutions.'[2] Following such demonstration, the next step should be the elimination of all rough areas on the tooth's surface which may retain bacteria on or in the tooth-surface, and this is accomplished by applying to them Arkansas and carborundum stones, swinging them across the enamel surfaces, thus bringing out all pits that have been induced by the acid formed by the bacteria on these surfaces, getting rid of the bacteria themselves and polishing out the inequalities, which serve to retain and foster bacterial growth. After the use of the coarse stones on the tooth-surfaces, disclosing solution should again be used to make sure that all pits have been beveled out. After all pits that contain bacteria and inequalities have been thus beveled out, and the application of the disclosing solution reveals nothing, then the tooth-surface should be thoroughly polished with fine Arkansas stones, and the brilliance increased by the use of moose-hide wheels loaded with jeweler's rouge or any other abrasive which will give a high degree of brilliance to the enamel. When the tooth's surface has been properly cared for in this manner we are then ready to attack the root-surface." Whether the prophylactic treatment is given the crown surface of the tooth before or after the root surgery, it should be done thoroughly before applying the medicinal treatment.

[1] Dental Review, September, 1915.

[2] Strong aqueous solutions of iodin and potassium iodid.

2. Medicinal Treatment.—After the teeth have been thoroughly scaled and polished, the mouth should again be carefully sprayed with the antiseptic solution, forcing it well between the teeth and around the gum margins to mechanically remove any loose deposit and pumice which may be left from the polishing. By the use of cottonoid rolls the parts treated can be kept dry and an application made of some astringent remedy. This can be worked with a glass instrument under the free margin of the gum and over the gum septum, keeping the parts dry for a few moments, when the mouth can again be thoroughly sprayed and rinsed with the antiseptic solution. If the teeth are at all responsive to heat and cold, the solutions used should always be warmed to the temperature of the body. Spraying outfits are now on the market which keep the solutions warm; and, if the dentist devotes much time to pyorrheal or prophylactic treatment, these outfits should constitute a part of the office equipment. The so-called "dental units" serve a useful purpose here. As a local astringent in these cases, the author suggests the following:

℞—Zinci phenolsulphonatis,
Potassii iodidi, āā gr. xx (1.3 Gm.)
Iodi (crys.), ℥ss (2.0 Gm.)
Mentholis, gr. iij (0.19 Gm.)
Thymolis, gr. ij (0.13 Gm.)
Glycerini, q. s. ad. f℥j—M.
Sig.—Use as directed above.

This remedy is called *pyorrhea astringent.*

The patients should now be instructed how to properly brush, massage, and care for their teeth generally, prescriptions should be written for a tooth-powder or paste and an antiseptic mouth-wash, and the patient dismissed until a second sitting. In giving the instruction relative to brushing the teeth and massaging the gums, it should be emphasized that the gums should be vigorously brushed as well as the teeth—thus we get the benefit of massage. Many hand and electrical appliances are also on the market for massaging the gums.

The above treatment, in practically every detail, should be repeated at each sitting until the mouth is in good condition, after which there will probably be little need for further medication. The patient should be requested to return at frequent intervals that the case may be watched, and each time the patient returns an examination should be made with respect to the care given the teeth. If all is well, the patients should be complimented; if not, they should be cautioned accordingly.

A 5 per cent. solution of dichloramin-T in chlorcosane is a useful and effective remedy in the treatment of periodontoclasia. After instrumentation the solution may be introduced into the pockets with an all-glass syringe, having a gold or platinum needle. If the pocket is sufficiently deep and it is thought best not to surgically eliminate it, a small pledget of cotton, soaked in the solution, may be gently inserted and permitted to remain for 24 hours, when it is removed and, if necessary, a second application made. The solution should also be applied locally to the surrounding tissues, which treatment should be continued until the tissues resume their normal color and tonicity.

Astringent Mouth-washes Contraindicated.—The general prescribing of mouth-washes containing highly astringent drugs, as the zinc salts, in the treatment of periodontoclasia, is, in the opinion of the author, wrong. It is true that certain tissues of the mouth need to be *constringed* and *stimulated* to healthy activity, but surely the entire mucous membrane of the mouth does not need to be so treated. Cook has shown that the continuous use of astringent mouth-washes interferes for hours with the action of the ptyalin upon starchy foods. The astringent remedy should be applied by the dentist to the parts only which need such treatment, and an antiseptic mouth-wash, together with the proper brush, tooth-powder or paste, and other utensils for the mouth toilet is all the patient should use. If the patient is to use an astringent remedy at all, the constringing agents should rather be a constituent of a tooth-paste than of a mouth-wash; though even this is unnecessary and inadvisable. A prescription for a tooth-paste follows:

℞—Calcii carbonatis ppt.,		℥iijss (112.0 Gm.)
Saponis,		℥ss (16.0 Gm.)
Sodii benzoatis,		℥j (4.0 Gm.)
Eucalyptolis,		
Olei menthæ piperitæ,	āā	m. x (0.6 cc.)
Thymolis,		gr. iv (0.25 Gm.)
Saccharini,		gr. iij (0.2 Gm.)
Glycerini,	q. s. ad.	pasta.—M.

Sig.—Use as a tooth-paste.

As a mouth-wash any known antiseptic solution can be prescribed. It is as unnecessary as it is unwise for the dentist to prescribe "cure-all" mouth-washes or those the constituents of which are to him unknown. The formerly official mouth-wash, Liquor Antisepticus, (N.F.) or Dobell's solution (N.F.) may be prescribed and diluted to suit the case. The formula for the Liquor Antisepticus follows:

Boric Acid,	5 dr. (20.0 Gm.)
Benzoic Acid,	15 gr. (1.0 Gm.)
Thymol,	15 gr. (1.0 Gm.)
Eucalyptol,	4 min. (0.25 cc.)
Oil of Gaultheria,	4 min. (0.25 cc.)
Oil of Peppermint,	8 min. (0.5 cc.)
Oil of Thyme,	2 min. (0.1 cc.)
Alcohol,	8 fl. oz. (240.0 cc.)
Water, to make	1 qt. (1,000.0 cc.)

In prescribing this solution it is never necessary to remember all of the various drugs and their quantities. We can take advantage of the fact that the solution was formerly recognized by the United States Pharmacopeia and write its official title, as:

℞—Liquoris antiseptici, f℥viij (240.0 cc.)
Sig.—Dilute with one-half of warm water and use as an antiseptic mouth-wash.

It is well to remember, however, that the solution contains about 2 per cent. of boric acid, 0.1 per cent. of benzoic acid and thymol, 25 per cent. of alcohol, and other aromatics and antiseptics added to water as the vehicle. Herein is illustrated a practical application of a knowledge of the Pharmacopeia and National Formulary.

In those cases complicated by indigestion and where the patient complains of a sour taste in the mouth, especially on rising in the morning, due either to local fermentation or to the regurgitation of acid from the stomach, the condition may be corrected by the following prescription:

℞—Sodii bicarbonatis, ℥j (4.0 Gm.)
Infusi gentianæ comp., f℥iij (90.0 cc.)—M
Sig.—Take a tablespoonful before meals and on retiring.

Where the sour taste comes purely from fermentation in the mouth, all that is necessary is to have the patients use frequently a warm solution of sodium bicarbonate, or the following alkaline and antiseptic mouth-wash may be prescribed:

℞—Sodii bicarbonatis,
Sodii boratis, āā ℥ss (2.0 Gm.)
Thymolis,
Mentholis, āā gr. ss (0.03 Gm.)
Alcoholis, f℥ijss (10.0 cc.)
Glycerini, f℥ij (8.0 cc.)
Aquæ cinnamomi, q. s. ad. f℥viij (240.0 cc.) —M.
Sig.—Use wherever an alkaline and antiseptic mouth-wash is indicated.

CLASS II

1. Surgical Treatment.—In this class of cases we are dealing with what may very properly be called true periodontoclasia, and in the surgical treatment it is especially necessary to use such instruments as will accomplish our end in a definite and certain manner. Here the exaggerated forms of the L.-B. set and those designed for scaling between the roots of molar teeth will be found extremely useful. If deposits are present, they *must be removed*, observing the same precautions as have been elsewhere mentioned. In the absence of deposits, the pockets, including both the affected tooth-surface and alveolar process, must be thoroughly curetted. We have here a more aggravated condition with which to deal, and from one to four teeth will doubtless be all that should be treated at one time, for the teeth thus operated upon are usually sore and more or less sensitive to thermal changes; therefore, the lesser number of teeth treated, the greater will be the comfort of the patient. The pockets are generally deep in this class of cases, and compressed air is an excellent agent to use for clearing the field and locating pockets. In the light of our present knowledge of focal infection and the grave systemic diseases resulting therefrom, it must ever be kept in mind that *all teeth which cannot be treated so as to be kept free from infection should be extracted.*

Indications for the Removal of Pulps.—The question of removing the pulps from the affected teeth in this class of cases is an important one. It was formerly thought that there were at least three indications for pulp removal, viz.: (1) where the pockets were deep and the infection in the apical area had left the pulp, if still alive, in a low state of vitality; (2) where it was necessary to adjust some mechanical applicance (see Figs. 157 and 158); and (3) where the tooth was so acutely sensitive as to cause constant annoyance to the patient.

Good judgment today, in the light of our present knowledge, would probably demand the extraction of most teeth in the first two groups of cases wherein, heretofore, pulp removal was followed. Contrasting the older interpretation with the newer, Price says, "Teeth with shallow or moderate pockets from periodontoclasia frequently, and with deep pockets from periodontoclasia usually, have their pulps already infected to some extent from that source." The statement relative to deep pockets may be correct, but the author seriously questions the contention that pulps of teeth are infected in cases of periodontoclasia where the pockets are shallow or moderate in depth. Dr. Price here, as elsewhere, frequently

confuses "presence of bacteria" with "infection." It should be remebered that infection means the successful invasion of a tissue by bacteria *with cellular change and tissue reaction.* Mere presence of germs is not sufficient to cause an infection. there must be some deleterious effect upon the tissue.

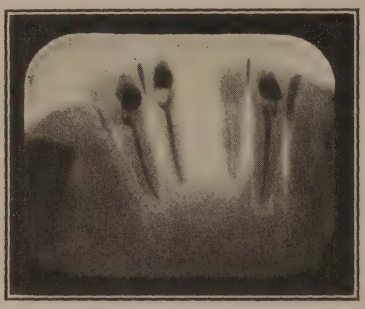

FIG. 157.

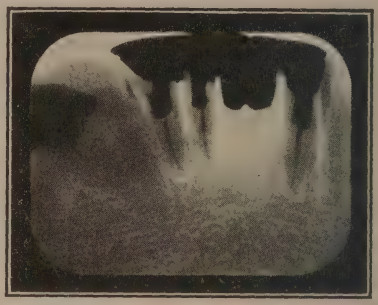

FIG. 158.

FIGS. 157 AND 158.—This is a case where there was an abnormal space between the lower central incisors, about the width of one tooth. All of the four incisors were loose; the left central hopelessly so. The pulps were removed from the two lateral and right central incisors, and the canals filled. The radiogram for Fig. 157 was taken Mar. 9, 1916. The combination bridge and retainer was adjusted a few days later. The radiogram for Fig. 158 was taken Nov. 30, 1916. The teeth are solid and comfortable, and the gums pink and healthy.

FIG. 159.—This radiogram shows the result of an incorrect diagnosis. Pus was flowing from between the two central incisors and from between the left central and lateral incisors. The condition was mistaken by the dentist for an alveolar abscess; he drilled into the left central only to find a live pulp, which was removed and root filled. In the operation the perfect natural crown was so mutilated that a Logan crown was subsequently adjusted. The pus still continuing to flow, an attempt was made to open into the lateral, as the radiogram shows. On finding another live pulp, the dentist became discouraged, to say nothing about the patient, and referred the case. The curettement of two rather stubborn pyorrheal pockets effected a cure.

In the third group the sensitiveness may be overcome and the tooth generally made comfortable by sealing desensitizing paste on the exposed cementum for a period of twenty-four hours, or, if a posterior tooth, by cauterizing the exposed cementum with

silver nitrate (see p. 100). The transitory sensitiveness following the scaling and polishing of the teeth may generally be reduced by polishing the surfaces with moist sodium bicarbonate, and having the patient rinse the mouth, especially before retiring, with a warm sodium bicarbonate solution.

It has been clinically observed by White, of Nashville, and others that the removal of the pulp of a badly affected pyorrheal tooth is followed by a more rapid response to the local treatment of the disease. The theory has been advanced that in the removal of the pulp the entire circulation of the tooth is thrown to the sluggish pericemental membrane and thus stimulation is brought about. This is an erroneous idea, for Noyes, Broomell, and others, have clearly demonstrated histologically that the pericemental membrane is normally well supplied with blood-vessels, and that to extirpate the pulp would not materially affect the circulation in this membrane. Fig. 159 illustrates the result of a mistaken diagnosis, where a pyorrheal condition was mistaken for an alveolar abscess.

Fig. 160.

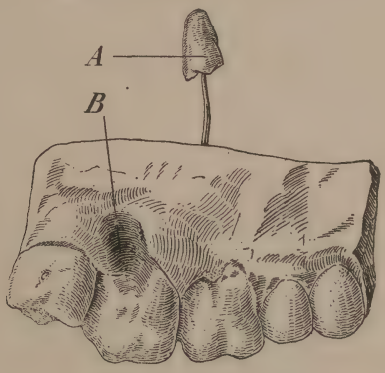

Fig. 161.

Fig. 160.—This shows an exposed molar root, such as is frequently encountered in the treatment of periodontoclasia.

Fig. 161.—This shows the case after the excision of the root. *A*, excised root; *B*, cavity after removal.

Denuded Roots.—Whenever a single root of a multi-rooted tooth is practically denuded of its pericemental attachment, with the remaining roots in fairly good condition, the badly affected root should be completely excised. Such a condition is illustrated in Figs. 160 and 161. (See also Figs. 162 and 163.) This necessitates, of course, the removal of the pulp and the filling of the root. If two roots are thus affected, the tooth should be extracted.

The use of local anesthetics by infiltration in connection with the surgical treatment of periodontoclasia, is not advised, as a rule. To further poison the tissues by actual injection when they are

already in a low state of vitality is contraindicated, and the slight anesthesia otherwise induced is too often obtained only at the expense of quite as much pain as the careful scaling and curetting with the proper instruments would produce. The parts not being anesthetized will serve as a guide to the careful operator in locating the pockets, when the surgical treatment can be accomplished with a minimum amount of injury to the soft parts involved. If care and judgment are exercised, neither the pain nor the discomfort is as great as might naturally be supposed. If local anesthesia is necessary for thorough scaling, the conduction method should be employed.

After the surgical treatment is completed, the prophylactic treatment with the usual instructions should be given. Patterson[1] states, "Experience has taught that the time spent in smoothing the roots is well worth the endeavor, for the rapidity and permanency of the recovery is greatly enhanced, and the operation cannot be considered completed until as much time is given to the polishing as to the removal of the deposits."

Elimination of Deep Pockets.—It is always best in deep pockets, where there is considerable detachment of the pericemental membrane, to surgically eliminate the pocket, as shown in Figs. 164, 165, and 166. This is done by using a local anesthetic solution or spraying the part with ethyl chlorid, when a V-shaped piece of the gum is removed. Often the mere slitting of the gum with a sharp lancet will suffice, if the pocket is packed to prevent the edges of the wound from uniting. It is far better to have an exposed root surface free from infection, than to retain a pocket which cannot be kept from reinfection. On this point, Noyes[2] says, "It is important to remember that whenever the fibers (of the pericemental membrane) have been stripped from the surface of the cementum, they can be reattached to it only by the formation of a new layer of cementum, building the fibers into it. This is certainly possible if the conditions are properly controlled, but the cells of the tissue must be in a normal and vitally active condition, and the surface of the root must be such that they can lie in physiologic contact with it. The cure of a pyorrheal case, therefore, becomes a biologic problem. In this connection it is important to remember that a surface of cementum which has long been bathed in pus may be so filled with poison that no cell can lie in contact with it and perform its function." Hartzell believes that these surfaces may be smoothed

[1] Johnson's Operative Dentistry, p. 467.

[2] Dental Histology and Embryology, page 248.

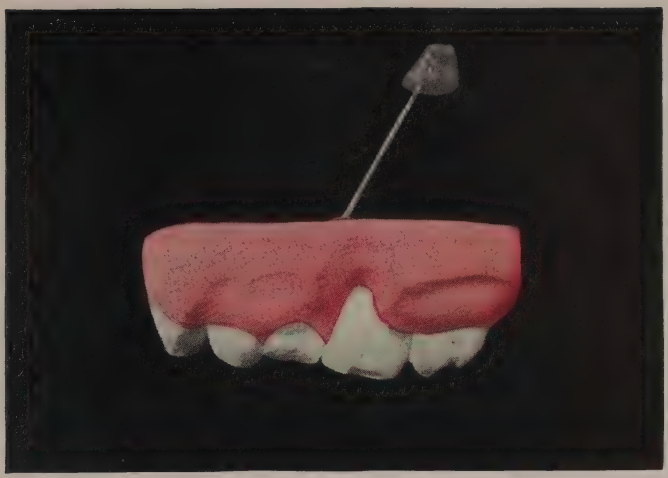

FIG. 162.—The picture here is of a model taken from a case after the mesiobuccal root of an upper first molar had been excised. The excised root is shown on the wire. With a little care, patients may keep such an area clean and the tooth may be saved for a number of years, free from infection.

FIG. 163.—The picture of the model on the right shows a case where the lingual root of an upper first molar was practically denuded of its pericemental attachment. The picture of the model on the left shows the case after the entire root had been excised and the tissues had healed. The excised root is shown on the wire.

FIG. 164.—The picture of this model shows the result of eliminating the pyorrheal pocket by surgically removing the overlying soft tissues.

FIG. 165.—This picture shows where a deep pocket on the distal of a lateral incisor has remained permanently cured for a number of years after surgically eliminating the pocket.

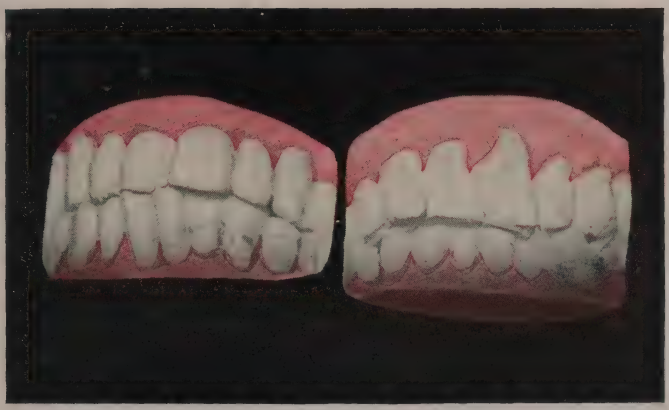

FIG. 166.—These are pictures of models of cases cured by surgically eliminating the pockets about the affected teeth.

by proper instrumentation and thus left free from bacteria and toxins, when the tissue surrounding the pocket is caused to bleed, filling the latter with a sterile blood-clot and, under favorable conditions, new bone is formed. This may be possible, but hardly probable, considering the conditions in the mouth. In extensive cases of periodontoclasia A. D. Black, Ward and others advise the entire surgical removal of the overlying soft tissues and the thorough curettement of the involved bone, keeping the parts protected until regeneration is effected, which follows rapidly if the operation is properly done. Ward has suggested the use of a protective material —a sort of cement, which aids materially in the healing of cases thus treated.

2. Medicinal Treatment.—The medicinal treatment for this class of cases is practically the same as for the preceding class. The pockets should be washed out thoroughly after the surgical treatment. This may be accomplished with either the spraying apparatus or water syringe, having a small point on the nozzle. Iodin, because of its penetrating and stimulating property, is especially efficacious in these bone affections. The case generally yields nicely when the application of the local astringent remedy is made at intervals of two or three days. The time of making the subsequent applications should gradually be lengthened, and in about two or three weeks the case should be ready for the patient to care for himself. It should be remembered that in this class of cases the patient, as well as the dentist, is confronted with a more serious proposition. The instruction, therefore, should be explicit and the progress of the case closely watched.

In stubborn pus pockets it is sometimes necessary to thoroughly cauterize the area involved in order to check the pus formation. For this purpose excellent results may often be had from the use of a 25 or 50 per cent. solution of phenolsulphonic acid. This is a valuable stimulating agent, and may be applied deep down in the pocket with a Dunn drop applicator; on general principles, however, the use of acids in the treatment of this disease is contraindicated, not because they will not assist Nature in effecting a cure, but because of the extreme sensitiveness which they produce. Phenolsulphonic acid is an exception to the rule, as this agent does not leave the teeth sensitive. It is generally best to surgically eliminate such pockets.

Occasionally the pus formation will persist in a pocket where we are reasonably certain that the ordinary surgical treatment has been thorough, and where also the pocket has been cauterized. Here we can suspect resorption of the root in the apical area, leaving sharp,

needle-like points, which keep up the irritation. In these cases it is necessary to extract the tooth. The author's experience with replantation as a last resort in the cure of badly affected teeth in pyorrheal or abscessed conditions has not been encouraging. For permanent results it is absolutely essential that the replanted tooth be held firmly in position by some permanent appliance, and generally its extraction and the insertion of an artifical tooth is far more sanitary and satisfactory. It is not a question here of what a dentist can do by his ingenuity and skill, but rather a question of what is best for the patient.

Head, of Philadelphia, a few years ago, brought forth the use of ammonium hydrogen fluorid as a tartar solvent in the treatment of periodontoclasia. The solution which he recommends is made as follows: Commercial hydrofluoric acid is completely neutralized with ammonium carbonate and ammonium fluorid formed which dissolves in the water present. This solution is filtered, and as such has little chemic action on the so-called "tartar" on the teeth. To make the more active acid salt solution the ammonium fluorid solution is now evaporated in a leaden dish to one-half of its original bulk, an equal amount of hydrofluoric acid is added, and the whole again evaporated to one-half of its bulk. The resulting solution is ammonium hydrogen fluorid. Great care must be exercised in making this solution, for if any of the hydrofluoric acid is left free, its action would produce serious results.

Head recommends making the application to a pyorrheal pocket with a rubber syringe having a platinum point or with a drop applicator. The claim is made that it will dissolve the deposit without any deleterious effect on the soft tissues. The author again desires to emphasize the precautions to be observed in obtaining a solution of ammonium hydrogen fluorid free from uncombined hydrofluoric acid, for a burn from this acid is at best a stubborn condition to treat, especially in the mouth where there is always danger of a mixed infection. For various reasons, the remedy has not met the earlier expectations.

Use of Emetin.—The discussion of the medicinal treatment of periodontoclasia would not be complete without at least brief reference to the use of *ipecac* and its chief alkaloid, *emetin*.

For years certain preparations of ipecac root have been used empirically in the treatment of *amebic* or *tropical dysentery*, an ulcerative disease of the intestines due to the presence of the *Endameba histolytica*. When Barrett and Smith discovered the universal presence of the *Endameba buccalis* in pyorrheal pockets, the use of emetin

at once suggested itself. Barrett recommends the local use of a ½ per cent. solution of emetin hydrochlorid, as stronger solutions cause irritation of the soft tissues. The solution is warmed and introduced into the pyorrheal pocket, using an ordinary hypodermic syringe with a flexible blunt needle. In addition to filling the definite pockets, a small amount of the solution may be permitted to run into the interdental spaces, care being taken to avoid any chance that the patient will swallow the remedy. Emetin is a prompt emetic. Such treatment should be repeated daily for five or six days, to be followed by similar treatments every other day for as many times. According to Barrett the amebæ disappear rapidly and are rarely found in the lesions after the second or third application.

Another method of using emetin in the treatment of periodontoclasia was introduced by Bass and Johns, after their discovery, almost simultaneously with Barrett and Smith, of the presence of amebæ in pyorrheal lesions. Their original method consisted of the hypodermic injection, in any part of the body, usually the arm, of ½ gr. of emetin hydrochlorid in solution. Ampules containing the proper dosage are readily obtainable. These injections were made daily for three or four days, repeating the treatment on one or more days after an interval of three to ten days. According to these authorities amebæ disappear from all lesions in practically all cases after six days' treatment.

Still another method of using emetin in the treatment of this disease is the oral administration of alcresta ipecac. This preparation is an absorption compound of the ipecac alkaloids, emetin and cephaëlin, with a form of hydrated aluminum silicate, an alkaloidal reagent discovered by Professor John Uri Lloyd, of Cincinnati, Ohio. This combination prevents the alkaloids from being dissolved in acid or neutral solutions and permits their solution in alkaline media only. In this manner these alkaloids pass unchanged through the stomach, which prevents entirely the nausea and vomiting caused by the oral administration of preparations of ipecac in any other form. This means that the alkaloids are physiologically inert as long as they remain in the stomach and become active when set free in the alkaline intestinal secretions, where they not only act on the amebæ and bacteria locally in the intestine, but whence they are absorbed and carried by the blood-stream to the alveolar lesions, acting there also upon the infecting organisms.

The tablets of alcresta ipecac should be given while the surgical treatment of the case is in progress or even preceding it. Two tablets in one-half glass of water one-half to one hour before meals

and on going to bed is the proper dosage to be continued for a period of five days, when the drug should be discontinued for about a week, at the end of which time a second course may be prescribed. In some cases there will be a slight looseness of the bowels after the fifth or sixth day. It is seldom necessary to discontinue the administration of the drug on this account.

The author has used emetin in every manner in which it has been suggested, both in college and in private practice; and I can say that there is no longer any doubt in my mind about the efficacy of the drug. Used locally, as suggested by Barrett and Smith, in my hands the remedy has been disappointing; but the results are surely noticeable when the drug is internally administered, as suggested by Bass and Johns. As stated above, there are two ways in which this may be accomplished: By the hypodermic injection of emetin hydrochlorid, and by the mouth administration of alcresta ipecac. So far as I have been able to observe, there is little, if any, difference in the results obtained by these two means of getting the drug into the circulation whence the blood-stream carries it to the alveolar lesions. Because of the ease of accomplishment, and also because of the local effects of the drug on the organisms in the intestines, the mouth administration is far preferable, and the results equally as good, if not better.

The present opinion of the author regarding the "emetin treatment" for periodontoclasia is that the remedy is *not a specific for the disease.* In itself, used as many physicians have used it, without the all-important local treatment, in my hands it will not cure the disease; but used internally, as the surgical treatment is undertaken and accomplished, the inflammation subsides more readily, the gums resume their normal color and tone more quickly, and the teeth and general mouth conditions are more comfortable than when the drug is not administered. I believe the future will demonstrate that emetin when internally administered has some therapeutic effect, other than its amebicidal action, which makes its use valuable in the treatment of certain mouth conditions. It may be its hemostatic action upon the blood.

The remedy is equally efficacious for flabby and bleeding gums and all other inflammatory conditions resulting from local irritants, and tending toward periodontoclasia. It must be remembered, however, that no remedy should be administered for such conditions without a thorough prophylactic treatment of the mouth. When Bass[1] made the statement that 95 per cent. of all adults examined by

[1] Journal of the American Medical Association, Feb. 13, 1915.

him had periodontoclasia, he must have used the term in a broad sense and included gingivitis and all other inflammatory mouth conditions. Strictly speaking these conditions should not be classed as periodontoclasia.

Use of Mercury Succinimid.—The effects of mercury succinimid, when internally administered, upon pyorrheal lesions was noticed wholly by chance by Dr. Paul G. White,[1] assistant dental surgeon, U.S.N., at the Portsmouth Navy Yard. In relating his experience White says: "Two patients, who had been under local treatment for periodontoclasia, presented themselves upon different days with gums swollen and exquisitely tender, and often with free salivation. Being unable to account for such conditions, which occurred at regular intervals, the patients were questioned, and the fact that they were also being treated for other troubles at the same time by Dr. Barton L. Wright, U.S.N., senior surgeon at the Yard, was brought to light. Investigations showed that both patients were being given deep muscular injections of mercury at regular intervals, and that the changes in the gum tissues and their hypersensitiveness were usually most prominent on the second day after treatment. The surprisingly quick cessation of the pus flow from the pockets and the corresponding return to normal of the gum tissues led to the introduction of mercury succinimid in other cases." These authors report startling results in a number of cases. The use of the remedy, as yet, has not been demonstrated to be practical, nor is it of sufficient value to be employed generally in the treatment of the disease. What the future holds forth, remains to be seen. There is no longer any doubt in the minds of those who have given serious study to the relation of periodontoclasia to systemic disease, regarding the effects of syphilis on the supporting or investing structures of the teeth. It may be that mercury will prove most beneficial in the treatment of mouth conditions when known to be associated with a specific history.

Use of Vaccines.—The raising of the opsonic index has been suggested as a means of combating periodontoclasia, as has also the use of specific vaccines (Hecker and others). The efficacy of these methods has not been sufficiently demonstrated to merit their discussion in a work on "practical therapeutics" at this time. In this connection, however, it should be remembered that we should never be in too great haste to remove foci of infection when the patient is systemically involved. In these cases, several pyorrheal pockets should not be curetted at one sitting, nor should several involved

[1] Dental Cosmos April. 1915

teeth be extracted at one time, on account of the reaction which frequently follows the disturbance of areas of infection. It is best in all such cases to confine the operation to one or two teeth.

It is to be hoped the true cause of periodontoclasia will soon be discovered, when the medicinal treatment can be instituted along more rational lines or, what would be better, such prophylactic measures inaugurated that the disease might be prevented. Herein lies a fruitful field for further investigation along the lines of food and diet. Too many people today are living artificial lives and expect natural results. It simply cannot be done. In our present state of knowledge it must be said that too much dependence should not be placed upon drugs, for at this time there is no known specific for the cure of the disease.

Where the loss of tissues has been extensive and the teeth are so loose as to interfere with their usefulness in mastication, and where the infection can be permanently eliminated without extraction, the correct treatment necessarily includes the making of mechanical appliances for their support.

3. Mechanical Treatment.—The importance of what the author has chosen to call the mechanical treatment of the disease under

FIG. 167.—This shows loosened lower anterior teeth, temporarily wired with a 26 gauge platinoiridium wire, to hold the teeth during the scaling process, after which a permanent retainer, as illustrated in Figs. 168 and 169, was adjusted.

FIG. 168.

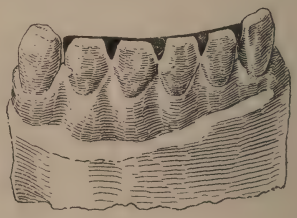

FIG. 169.

FIG. 168.—This shows the retainer in wax with the sprue inserted ready to be invested for casting.

FIG. 169.—This shows the completed appliance set on the model.

DIRECTIONS FOR MAKING

A modeling compound impression is taken of the cutting edge and upper lingual third of the teeth to be included in the appliance. From this impression a model is made with a good investment material. It is best to let it set over night, when the modeling compound can be removed by using dry heat. Care should be exercised not to chip the margins of the investment teeth. On this model the retainer can be made in wax just as it is desired when completed. The model is trimmed so it can be put into a casting flask, the sprue inserted and it is ready for investing (Fig. 168). After casting, it is finished and set in the usual manner (Fig. 169).

consideration has previously been emphasized. A detailed description of the method of making the various mechanical appliances is not properly included in a work of this character. The proper appliance for holding loose teeth in the jaw will naturally suggest itself to the ingenious dentist. They consist of a combina-

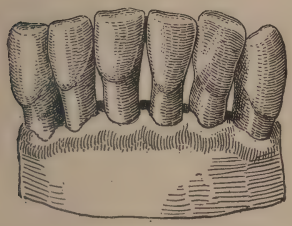

FIG. 170 A.

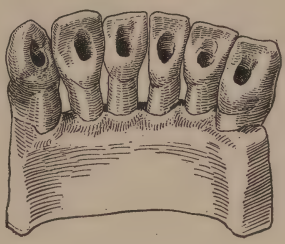

FIG. 170 B.

FIG. 171 A.

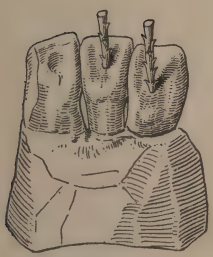

FIG. 171 B.

FIG. 172 A.

FIG. 172 B.

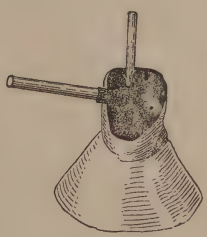

FIG. 173 A.

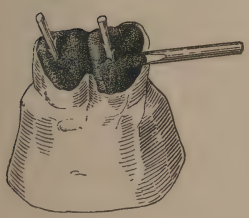

FIG. 173 B.

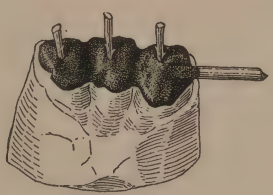

FIG. 173 C.

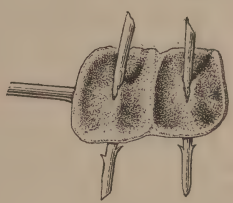

FIG. 174.

FIG. 170.—"A" and "B". Loose teeth from which the pulps have been removed, the canals filled, prepared for insertion of soft platinum wire and ready for the wax pattern or modeling compound impression.

FIG. 171.—"A" and "B". One or more teeth with soft platinum wire in position. The exposed end is barbed to hold either in the wax pattern or the impression material. The operator may prepare the wax model for casting directly upon the tooth, or upon the models.

FIG. 172.—"A" and "B". Modeling compound impressions of one or more teeth.

FIG. 173.—"A", "B" and "C". Models of one or more teeth made from impressions, waxed and ready for investing for casting. Notice the pin has been placed to direct the flow of gold *by* rather than *at* the model. Models made of equal parts of plaster and silica.

FIG. 174.—Double wax model made directly upon the teeth and ready for investment.

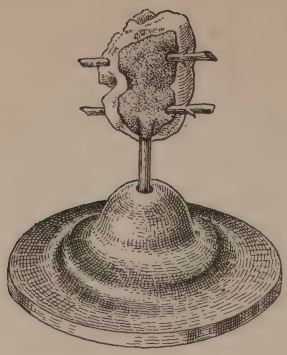

FIG. 175.

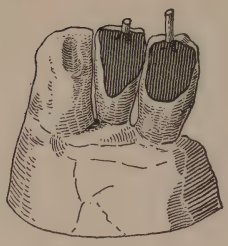

FIG. 176.

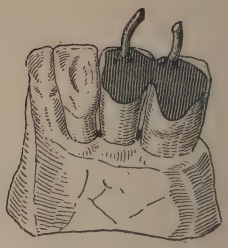

FIG. 177.

FIG. 175.—Method of investing.

FIG. 176.—Two castings in position and ready for the impression. Notice that the exposed end of soft platinum wire has not been cut off. Do not attempt to assemble more than two at one time, and take the impression of the parts ready to be united either with a small piece of modeling compound or just a little plaster. Fill the impression with ordinary soldering investment, separate and solder.

FIG. 177.—Two castings soldered. Continue in this manner, making single, double or larger castings, either from models or by carving the wax upon the natural tooth.

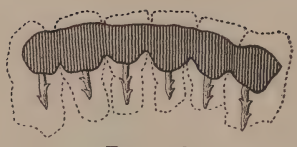

FIG. 178.

FIG. 179.

FIG. 178.—Finished case with pins well barbed. Do not cut barbs opposite each other; and remember not to cut off the exposed ends of soft platinum wire until the case is ready for the final polishing. No gold should be noticeable in the patient's mouth. The larger barbs will prevent a tooth that has been shortened from dropping below the others.

FIG. 179.—A case with loss of the lateral incisor.

FIG. 180.—Retaining appliances replacing lost incisor. Many cases present where one or more teeth have been lost and the others are very loose. This appliance will support the loose ones and replace the lost ones.

FIG. 181.

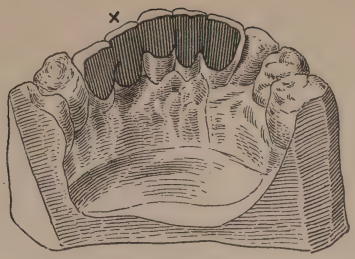

FIG. 182.

FIG. 181.—Labial view.
FIG. 182.—Lingual view.
This method can be used in any place in the mouth to support loose teeth and to carry bridged ones.

Where it is desirable to retain the pulps, use one or two short soft platinum pins in each tooth and prepare nearly parallel pits as far away from the pulp as possible. Before placing the appliance, barb the pins well and undercut the cavities. (*L. K Stewart.*)

tion of inlays, crowns and bridges, the so-called splints, and various retainers. For the benefit of the beginner a splint suggested by Dr. C. L. Hine, of Tuscola, Ill., for loose teeth, the pulps of which need not be devitalized, is illustrated and briefly described in Figs. 167, 168 and 169. On the preceding pages the reader will find Figs. 170 to 182, inclusive, with descriptions which were furnished the author by Dr. Lee K. Stewart, of Los Angeles, and explains his former method of treating the conditions under consideration from the mechanical viewpoint. It should be borne in mind that *no tooth should be retained in the mouth that cannot be kept free from infection.*

CLASS III

In considering the therapeutics of this class of cases from the dental viewpoint it can be stated that the treatment is both *local* and *general.*

1. Local Treatment.—The local treatment involves practically the same surgery, drugs and remedies, and mechanical appliances as in the preceding classes, modified only to meet the conditions as found. To be effective and permanent the treatment by the dentist must be given conjointly with the general treatment by the physician in charge.

2. General Treatment.—Whenever the local condition in the mouth seems to be aggravated, if not caused, by some of the systemic diseases elsewhere mentioned, it is the plain duty of the dentist to refer the patient to his family physician for the general treatment. In fact, it is almost useless to undertake the local treatment unless measures are simultaneously instituted for the correction of the systemic disease; but when the physician and dentist work together in harmony, it is surprising what great relief can be given the patient

by the proper local treatment, for the mouth in many instances is in a hideous condition.

It has been elsewhere stated that in diabetic complications, the gums are often turgid and raw, the pericemental membrane is inflamed and highly sensitive, there is a marked tendency toward the formation of serumal deposits—pus may or may not be present. The author feels that because of these characteristic mouth symptoms, he can almost positively diagnose a case of advanced diabetes by this means alone. In this relation it is interesting for the dentist to learn of the discovery of *Insulin* recently by Dr. Banting and Mr. Best of the Toronto University Medical school. In this country the product is known by its trade name—*Iletin*. These names were given the product because it is derived from the cells of the pancreas known as "islet tissue," or the islands of Langerhans. The commercial development of Iletin was intrusted to the Research Laboratories of Eli Lilly and Company, and in the past year the purification, standardization and production of this extremely valuable agent for the treatment of diabetes was perfected and adequate amounts were available for all diabetic patients in this country. The Toronto group wisely decided, however, to restrict its use principally to hospitals, diabetic clinics and physicians with a large experience in treating this disease, until such time as its proper mode of administration could be established and full clinical reports of its use be made to the medical profession. These reports have now been published.

In all cases wherein some systemic complication is suspected, the dentist should not fail to have the urine examined for at least such abnormal constituents as albumin and sugar. With a little practice the dentist may readily make these tests himself. A brief, but practical outline for the examination of the urine will be found on p. 558.

In conclusion, I desire to state that it is a pleasure to work for pyorrheal patients. In many instances they have been informed that nothing could be done, and that they must soon lose their teeth; therefore, in most cases, they appreciate fully your every effort.

NEURALGIA

GENERAL CONSIDERATIONS

Neuralgia may be defined as a severe paroxysmal pain in the area of distribution of a nerve, or along its course; and, according to Barrett, true neuralgic pain is principally confined to the afferent or sensory nerves, but it may be of a reflex character and hence have its origin in the efferent or motor nerves. It is not a disease in itself, but is rather a manifestation of a disease or perverted function; therefore, the conditions which may cause neuralgia are many and varied; and, for convenience in study, they may be classified as follows:

I. General Diseases.

1. *Those Which Lower Tissue or Functual Resistance.*—This class includes anemia, or other diseases which interfere with such vital functions of the body as the circulation, respiration, secretion, digestion, assimilation and elimination.

2. *Those Which Produce Foreign or Abnormal Substances in the Blood.*—This includes syphilis, gout, rheumatism, diabetes, nephritis, malaria, chronic pyemias or any foci of infection, metallic poisoning, etc.

II. Local Diseases.

1. *Those Which Cause Reflex Peripheral Irritation.*—In this class are included *diseases of the teeth*, eyes, ears, stomach, uterus, and ovaries.

2. *Those Which Produce Pressure.*—This includes various tumors, and especially such abnormal growths as occur within bony canals through which nerve-trunks pass.

3. *Chronic Inflammation of the Nerve-sheath or of the Nerve Itself.*—This includes neuritis, or actual diseased conditions of the nerve.

III. Certain Intractable Cases.

This class includes a large number of cases of neuralgia for which no cause can be found.

The neuralgias which generally come under the observation of the dental practitioner are chiefly those manifested in the area of distribution or along the course of the fifth cranial nerve, and are accordingly called *trifacial* or *trigeminal neuralgia.*

TRIFACIAL NEURALGIA

There are many local conditions in and about the teeth which may cause trifacial neuralgia. Chief among them are:

1. Pulpitis.
2. Pulp nodules, partially calcified pulps, and secondary dentin.
3. Pericementitis.
4. Cementosis.
5. Deposits on the roots of teeth.
6. Infections about the roots of teeth.
7. Exposed dentin and cementum.
8. Impacted teeth.
9. Faulty occlusion.

THERAPEUTICS

The first essential in the treatment of neuralgia due to diseases of the teeth is to ascertain the cause and remove or correct it, if possible. As Harlan says: "The dentist should consider no time lost in an endeavor to find the cause of trifacial neuralgia." It is essential here, as in all treatment cases, to make a correct diagnosis. In most cases the symptoms are of the subjective variety and a correct diagnosis is often difficult to make. It is necessary oftentimes to take into consideration the diseases outlined in the classification on the preceding page; and it is also well to remember that women are especially prone to neuralgia during the period of menopause, the so-called "change of life." Fortunately, however, by means of radiography many of the conditions mentioned as being productive of trifacial neuralgia may be positively diagnosed. Illustrations of several of these conditions are found on the following page in Figs. 183, 184, 185, 186, 187 and 188. The late Dr. J. N. Crouse, of Chicago, reported an interesting case in his practice which occurred before radiography was known (see Figs. 189, 190, 191 and 192). The author desires to emphasize the importance of ascertaining, if at all possible, the cause of the neuralgia, for upon this depends largely the method of applying our therapeutics. In radiographing the teeth for possible causes of neuralgia, it is well always to radiograph the areas where teeth have been extracted. In this way many an obscure cause may be located in a root-end which had been left and which has a low grade infection associated with it. With the cause known, the treatment is of two kinds—*medicinal* and *surgical.*

FIG. 183.—This radiogram shows an impacted lower third molar, frequently the cause of trifacial neuralgia.

FIG. 184.

FIG. 185.

FIG. 186.

FIG. 187.

FIGS. 184, 185, 186 and 187.—These all show cementosed roots, the cause of trifacial neuralgia.

FIG. 188.—This shows a lower third molar coalesced to and between the roots of the lower second molar.

I. Medicinal Treatment.—The medicinal treatment of trifacial neuralgia may be subdivided into *local* and *general*.

1. Local Treatment.—There are many drugs and remedies which act favorably upon the sensory nerve-endings, and are, therefore, efficacious in the local medicinal treatment of this disorder.

FIG. 189.

FIG. 190.

FIG. 191.

FIG. 192.

The above figures are illustrations of perfectly sound teeth which were extracted from one mouth. The symptoms were different from those of any other case with which I have had to deal. When the patient first presented, in the middle of the night, he was suffering such severe paroxysms of pain that during one of the attacks he dropped to the floor almost senseless. The attacks were of short duration, but several occurred before I could learn what the trouble was. Directly after one of these spells, by tapping the teeth on the side where the pain was most severe, I found slight sensitiveness; particularly was this so of the first upper bicuspid, although the pain radiated all over the head. I attempted to drill into this tooth and found the canal obliterated, so I extracted it (Fig. 189). Notice also the cementosed root. The history of the other teeth (Figs. 190, 191 and 192) is similar, except that I could locate the trouble with less difficulty after the first experience; then, too, the disease had not progressed quite so far before the teeth were extracted. I lost track of the patient and do not know whether he had further trouble or not. . (*J. N. Crouse.*)

The author's dental liniment mentioned in connection with non-septic pericementitis (p. 433) will often give excellent results, or any of the following remedies may be prescribed:

℞—Mentholis, gr. xxx (2.0 Gm.)
Alcoholis,
Etheris, āā f℥vi (24.0 cc.)
Chloroformi, q. s. ad. f℥iij (90.0 cc.)—M.

Sig.—Apply by vigorous rubbing or massage over the area of distribution of the affected nerve, or along its course.

℞—Camphoræ (gum), ℥ij (8.0 Gm.)
Tincturæ aconiti, f℥j (30.0 cc.)
Linimenti saponis, q. s. ad. f℥iij (90.0 cc.)—M.

Sig.—Use as above.

W. H. Truman suggests the following:

℞—Camphoræ (gum), ℥j (4.0 Gm.)
Etheris, f℥ij (8.0 cc.)
Alcoholis, f℥j (30.0 cc.)
Chloroformi, q s. ad. f℥iij (90.0 cc.)—M.
Sig.—Use as above.

The various liniments here given have practically the same therapeutic effect—that of a sedative upon the peripheral sensory nerves.

In cases where the pain comes from pericementitis or from a developing abscess associated with the upper anterior teeth, it may be stopped in many instances like magic by spraying the posterior nares with alcohol and water, as suggested by Keefe (see p. 439).

Electricity is often of great value. Marshall suggests applying the positive pole of a galvanic battery to the painful spot, when a current of from one to three milliamperes is applied for from two to five minutes. Freezing the area with ethyl chlorid will frequently afford much relief, especially in cases of acute pericementitis. This latter agent may also be sprayed along the distribution of the affected nerve, with gratifying results in many cases.

2. General Treatment.—The general medicinal treatment involves the administration of drugs systemically. If certain drugs are indicated for the correction of some systemic derangement which is causing reflexly the trifacial neuralgia, as, for instance, iron compounds in anemia, quinin in malaria, arsenic, mercury and iodids in syphilis, etc. they had better be prescribed by the family physician. Here again is a condition wherein the best results from the treatment are obtained only when both the family dentist and the physician work in harmony. Cases have been authentically reported where physicians had treated patients systemically for neuralgia for months without effect, when ultimately the case was cured instantly by the dentist in relieving some local condition about the teeth; while, on the other hand, dentists have been known to keep patients suffering for months in an endeavor to locate the cause about the mouth, when ultimately the correction of some systemic trouble cured the local neuralgia.

While patients should be referred to the family physician for the general treatment of constitutional diseases, it is not only the privilege but the plain duty of dentists to prescribe internal drugs for the relief of pain while the cause of the neuralgia is being searched for and removed. It is true that this involves a knowledge of drugs and their uses, but surely this is not too much to expect of the trained dental practitioner of to-day. The classes of drugs indicated for the

control of pain are the hypnotics or general anodynes or analgesics. Several prescriptions are here given. The practitioner can select the one which best seems to suit the case at hand.

℞—Pulveris acetanilidi comp., gr. xx (1.3 Gm.)
Fiat chartulæ No. iv.

Sig.—Take one powder every hour until two or three are taken; if not relieved after two or three hours, take the remaining one or two.

In cases of neuralgia of rheumatic origin acetphenetidin may be combined with salophen and codein sulphate to control the pain. A prescription follows:

℞—Acetphenetidini,
Salophen, āā gr. xx (1.3 Gm.)
Codeinæ sulphatis, gr. j (0.06 Gm.)—M.
Fiat chartulæ No. iv.

Sig.—Take one powder every two hours.

NOTE.—This prescription will require a Federal blank, with the prescriber's registered number.

When the neuralgia is associated with nervous headache the following prescription may be given:

℞—Caffeinæ citratis, gr. xij (0.8 Gm.)
Acetphenetidini, ℥ss (2.0 Gm.)—M.
Fiat chartulæ No. vj.

Sig.—Take one powder every two hours until relieved.

Occasionally patients do not like to take a powder, preferring a liquid preparation. In these cases we can prescribe antipyrin in solution with an aqueous vehicle, for, unlike acetanilid and acetphenetidin, this drug is soluble in water. Sometimes it is advisable to combine the coal-tar analgesics with a bromid; a prescription for such a combination is here given:

℞—Antipyrinæ, ℥ss (2.0 Gm.)
Sodii bromidi, ℥j (4.0 Gm.)
Glycerini, f℥ss (15.0 cc.)
Aquæ cinnamomi, q. s. ad. f℥ij (60.0 cc.)—M.

Sig.—Take a dessertspoonful three times a day, and oftener if conditions necessitate.

Sometimes the coal-tar analgesics fail to produce the desired effect, in which case there is always one drug that can be relied upon to control the pain, and that is morphin. This drug is truly indicated for the control of pain from whatever source and may be given here in ⅛ gr. (0.008 Gm.) dose, but under no conditions should a prescription be written for the drug. Many patients are in the

habit of keeping a copy of the prescription, and when the remedy works well in a certain case they often get the prescription refilled for themselves or friends on the least provocation. In the case of morphin this might innocently lead to the "habit." Tablets containing the usual dose (⅛ gr.–0.008 Gm.) may be kept on hand, and, if necessary, two such tablets may be given by the stomach within one-half hour, and then the patient can take one tablet home—never more than one, if two have been given at the office—which can be taken in the course of an hour, if not relieved. It is necessary to keep a record when using drugs which come under the "Federal Antinarcotic Law." Fortunately, it is seldom necessary for dentists to prescribe opium or its alkaloids; but when indicated, in their judgment, they have the legal right to prescribe any drug to relieve suffering humanity. This is not true at the present time regarding the prescribing of whisky or brandy, as elsewhere mentioned.

Of the newer synthetic products, pyramidon is one of the best. This may be prescribed in five-grain (0.3 Gm.) tablets every two hours until relief is obtained, or until four or five tablets have been taken. It should be remembered that no drug should be taken continuously for the relief of pain. These remedies are only intended to control the pain until the cause is corrected or removed.

When the patient is unable to sleep, chloral hydrate or butyl-chloral hydrate may be prescribed. The fifth cranial nerve is supposed to be especially sensitive to the influence of butyl-chloral hydrate. A prescription follows:

℞—Butyl-chloralis hydratis, ʒj (4.0 Gm.)
Fiat capsulis No. xij.
Sig.—Take one capsule every three hours until four are taken.

Amytal in 1½ gr. (0.092 Gm.) doses may also be given for sleeplessness. There is no after effect to the administration of this drug.

In cases where a tonic is indicated, as in anemia, the syrup or glycerite of iron, quinin, and strychnin phosphate (N.F.) may be given. A prescription for the syrup follows:

℞—Syrupus ferri, quininæ et strychninæ phosphatis, fʒiij (90.0 cc.)
Sig.—Take a teaspoonful in water before meals.

Where the neuralgia is of malarial origin, quinin is indicated. An excellent prescription follows:

[1]℞—Quininæ valerianatis,	gr. xviij (1.2 Gm.)
Extracti hyoscyami,	gr. iv (0.25 Gm.)
Extracti cinchonæ,	gr. viij (0.5 Gm.)—M.
Fiat capsulæ No. xij.	

Sig.—Take one capsule before meals and on retiring.

It will be noticed that only a few doses have been prescribed in any of the above prescriptions. This precaution has been taken because some of these patients suffer untold agony; in fact, they may be considered temporarily demented, and no matter how specific your verbal and written directions have been, they may ignore your directions entirely and take one dose after another on the general principle that "if a little is good, more is better," until they have taken such a quantity as may result in an overdose. Therefore, it is well for dentists, especially, to be careful in this respect.

II. Surgical Treatment.—The surgical treatment often involves major surgery, for a discussion of which see works on Oral Surgery.[2]

TIC DOULOUREUX

The discussion of trifacial neuralgia would indeed be incomplete without at least brief mention of *tic douloureux*, so named by Trousseau, a Frenchman. The condition frequently results from chronic irritation of the fifth cranial nerve. The pain is very acute, and occurs in distinct paroxysms, gradually increasing in severity, until it reaches a climax, when it quickly subsides. The attack may occur at any time and may be provoked by laughing, talking, the movement of a muscle, etc.; even a slight noise or light touch, as placing the hat on the head, may cause a paroxysm. The patient lives in constant dread of an attack.

There is no condition which elicits greater sympathy than this, for the experienced physician or surgeon realizes that little can be done either medicinally or surgically. Materia medica has been exhausted in search of a cure, and surgery affords only temporary relief. Patrick, Moyer, and others report favorably upon the use here of castor oil. The drug is first pushed almost to catharsis, then the dose is decreased, but the administration of the drug is still kept up. Ultimately the patient can take large quantities of castor oil without the cathartic effect.

Stekoulis, Schapiro, Bennett, Murphy, and others have injected osmic acid into the substance of the affected nerve and report encouraging results. The late Dr. J. B. Murphy, however, has

[1] Taken from the *Dental Cosmos*.

[2] "Oral Surgery," by Dr. Truman W. Brophy, is highly recommended.

directed attention to the great tendency of nerve tissue to regenerate; and states that many cases of tic douloureux will recur, even when the affected nerve has been severed by destroying an area with osmic acid or when blocked with such material as gutta-percha.

Deep injections of alcohol in the region of the orbit of the affected nerve have been recently suggested for the relief of trifacial neuralgia. Patrick, Moorehead, Logan, Potts, and others report favorably on the method. The needle generally employed is one adopted by Levy and Bandonin, which is graduated in centimeters up to five. The alcohol should be about 75 per cent., and should contain a very small amount of cocain hydrochlorid or procain hydrochlorid. The success of the operation will be indicated by a slight anesthesia over the parts supplied by the nerve. Upon the slightest return of the pain the operation should be repeated, after which relief for some months, and even two years or more, may be expected. The formula used by Patrick is here given:

℞—Cocainæ hydrochloridi,		gr. j (0.064 Gm.)
Chloroformi,		m. x (0.61 cc.)
Alcoholis,		f℥iij (12.0 cc.)
Aquæ distillatæ,	q. s. ad.	f℥ss (15.0 cc.)—M.

Sig.—Use as directed above.

On the whole, it may be stated that the therapeutics of tic douloureux is discouraging to all concerned. Hirt sums up the conditions very properly when he says: "Numerous are the means at our command for combating tic douloureux, and quite as numerous are the patients who, after hundreds of unsuccessful trials, have given up in despair all medicines and all physicians."

The condition has not been thus briefly discussed here because of the likelihood of dentists being called upon to treat it, but rather because they are often called in consultation on the case to aid in making a correct diagnosis.

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DIAGNOSIS AND TREATMENT OF DISEASES OF THE SOFT TISSUES OF THE MOUTH NOT DIRECTLY ASSOCIATED WITH THE TEETH

GENERAL CONSIDERATIONS

In this general group will be considered certain diseases of the soft tissues of the mouth other than those directly associated with the teeth. The etiology and pathology of these diseases will be considered somewhat more fully than has been done with the diseases of the hard tissues of the mouth and associated structures, for the reason that dentists, as a rule, are not so familiar with the etiology and pathology of the diseases under consideration here, and, therefore, find it more difficult to differentiate between some of these conditions and to make a correct diagnosis—upon which the successful therapeutics is based. Our profession has been criticised in the past, and, perhaps, in a measure justly so, because it is claimed that in our examinations of the mouth we have been looking only for cavities in the teeth and have not noted, at the same time, the condition of the oral mucous membrane and soft tissues. The tendency is to broaden our perspective, and the live dentist of to-day realizes the importance of a knowledge of the pathology of the soft tissues of the mouth as well as of the teeth themselves.

The mouth is a hot-bed for many kinds of bacteria, and is therefore a fruitful field for diseases of almost every description. Some of these diseases are purely local, having certain definite causes, while others are local manifestations of some general disorder. Even those diseases that are caused by local infections are influenced in most instances by the condition of the stomach or general metabolism of the individual. The mouth and the stomach are intimately connected and closely related; so much so in fact that pathologic conditions in the one often predispose to disease in the other. We can more readily understand the close relation that exists between diseases of these two organs when we remember that much of the septic material of the mouth ultimately finds its way to the stomach and intestines, and the toxins absorbed from the digestive tract are frequently excreted in the saliva. Michaels claimed the saliva to be pathognomonic of certain systemic diseases, the diagnosis being made by him solely by physical and chemic examinations of the saliva.

Some of the diseases of the mouth are characteristic and easily differentiated and diagnosed; while the correct interpretation of the clinical manifestations of others is exceedingly difficult and oftentimes baffles the most skillful diagnostician. In our larger cities we are fortunate in having the pathologic laboratories which must frequently be used in order to confirm our clinical diagnosis.

CANKER SORES

Canker sores are true ulcers and are among the more common pathologic conditions of the soft tissues of the mouth. They are supposed to have their origin primarily in the mouth, yet Pusey and others believe them to arise from trophic disturbances. The author has observed that women are peculiarly susceptible to this condition during the menstrual period. Some women have canker sores nearly every time they menstruate. They seem to be associated also with gastrointestinal disturbances. They always appear suddenly and are sometimes very persistent unless given suitable treatment.

Diagnosis.—Gilmer[1] states that "they most commonly occur at the duplicature of the mucosa of the cheek and the gums, though they are occasionally seen on the floor of the mouth and on the edges and under the surfaces of the tongue. They vary in size from that of a grain of wheat to that of a small-sized bean. Their depth varies, but they can never be considered superficial. Their margins are rather well-defined, but not so markedly as are chancrous ulcers of similar tissues, neither are they so irregular as lupous ulcers of the mouth. The mucosa for a quarter- to a half-inch from the ulcer is a deep red color. The base of the ulcer is overlaid with a grayish-white necrotic covering, not unlike that found in syphilitic ulcers in the mouth. When this coating is removed, a granulating surface is exposed, which, while extremely sensitive to the touch, bleeds but slightly, if at all. These ulcers are so distinctive in their appearance that they can hardly be mistaken for any other lesion."

Therapeutics.—The treatment of canker sores is purely local, and the sooner it is instituted the less persistent the ulcer will be. The necrotic tissue may be carefully removed by scraping, or cleansed with hydrogen dioxid, after which the raw surface should be dried and cauterized. They generally yield nicely to one application of silver nitrate. For this purpose a 10 per cent. solution may be used; a 20 per cent. solution of argyrol may also be employed. The ulcer being acutely sensitive, it is sometimes better to use 95 per cent.

[1] *Dental Review*, Vol. XXIII, p. 496.

phenol as the cauterizing agent. The analgesic effect thus produced is often of value. The mouth should be kept clean, when the ulcers usually heal without futher treatment.

HERPES LABIALIS

Herpes labialis, also called cold sores or fever sores, have a similar origin to canker sores. A chill, either nervous or from a cold, is the chief cause. They are of a herpetic nature, and differ in appearance from the latter principally on account of the location and tissues involved. Of these Gilmer says: "Herpes of the lips (herpes labialis) and occasionally of the gums (herpes gingivalis) sometimes follow dental operations and cause uneasiness on the part of patient, who often attributes this condition to infection from unclean armamentarium used by the dentist, when, in truth, the patient is of a herpetic diathesis, and under such circumstances a slight irritation only, in such locations, being sufficient to excite the condition."

Diagnosis.—The diagnosis of cold sores is a simple matter. They occur frequently when the patient is suffering from colds or during convalescence from fevers, hence the name. The tissues immediately around the area involved are swollen and tender; the membrane is dry and has a tendency to crack and bleeds readily.

Therapeutics.—The treatment of cold sores consists in cleaning the part with such agents as hydrogen dioxid or alcohol, then drying and making an application of oil of cloves or spirit of camphor. Either of these latter agents is just sufficiently irritating to produce stimulation of the cells and promote healing. If the cold sore is large and liable to crack and bleed on moving the lips, it can be kept soft and pliable by frequently applying euroform paste, or may be immobilized by applying collodion. In the latter instance the part should be dusted with boric acid before coating with collodion.

SYPHILIS

Syphilis is a chronic infectious disease now known to be produced by a specific microorganism, the *spirocheta pallida*—a germ discovered March 3, 1905, by Schaudinn and Hoffmann. This disease is much more common than is generally supposed, and it is essential that every practising dentist be familiar with its characteristic symptoms. Skill in the diagnosis of syphilitic manifestations is of the utmost importance, not only for the protection of the dentist himself, but for the protection of his patients as well. Whenever the skin on the hand or finger of the dentist is broken, or the mucous membrane of the patient's lip, gum, or cheek is punctured by an instrument, the

part should be immediately cauterized. It matters not whether the dentist ever expects to treat a case of syphilis, or not, the menace of the presence of this disease can only be avoided by the careful and intelligent reading of the clinical symptoms.

Acquired extragenital syphilis is primarily manifested in and about the soft tissues of the mouth in what is known as the initial lesion or *hard chancre*, which, as a rule, develops in from fifteen days to a month after infection. The chancre may occur in various locations—on the lip, tips of the tongue, and the pharynx—and is characteristic of what is known as *primary symptoms*.

Primary Syphilis.—The infection here is produced by direct contact of the spirocheta pallida with an abraded surface. According to Logan,[1] the principal means of conveying the infection extragenitally is through the act of kissing, drinking from a broken utensil, the use of a pipe or handkerchief that has been contaminated with the germ, or from physicians' or dentists' instruments or fingers that have had the infected secretions from the mouth of a previous patient dried upon them.

Diagnosis.—In the locations found in the mouth, chancre is usually single, though it may be multiple (Fig. 193). It may appear first as a papule, the superficial cells of which finally ulcerate, with necrosis of the central area quickly following, when a copious and *highly infectious* discharge comes from the crater-like opening that is forming on the tissues involved. The ulceration occurs in from four to ten days after full development of the chancre, until which time the patient, as a rule, experiences very little pain or discomfort.

Therapeutics.—The treatment of the primary symptoms, until recent years, was considered unimportant. In fact, unless a positive diagnosis could be made, and it is still often difficult to be certain of the clinical diagnosis at this stage of the disease, it was suggested that the treatment be deferred until the diagnosis was established by the manifestations of the secondary symptoms. This has been changed. Ehrlich, the discoverer of salvarsan—or "606," as it is commonly called, also neosalvarsan the new specific for syphilis, says, "too much weight cannot be laid upon the importance of diagnosing a syphilitic sore as soon as possible. We should certainly not wait for secondaries to develop or until the Wassermann reaction has become positive. In no period of syphilis is salvarsan more strongly indicated than when the chancre is the sole symptom." Syphilis is now known to be a germ disease, and the only positive means of confirming the diagnosis of the clinical symptoms in this stage is

[1] *Dental Review*, Vol. XXII, p. 800.

the microscope by which the *spirocheta pallida* may be discovered. These appear as fine, closely coiled spirals, 6 to 15 microns long, and feebly motile. They are most abundant in the margins of the lesions, and are practically constant in chancre and mucous patches. Old chancres and those treated by local antiseptics may easily fail to show the organisms (White and Martin).

The technic of injecting salvarsan or neosalvarsan will not be described here, for the author believes it to be the duty of the dentist, as soon as he observes the suspicious sore in the mouth, to consult with the family physician, who should inaugurate and follow up the specific treatment. Oral hygiene, of course, should not be neglected.

For a great many years mercury has been the only specific for syphilis, except in the tertiary stage when potassium iodid is indicated. But, unfortunately, mercury in its curative dose is extremely poisonous, so that small doses must be used for a long period of time. Because of this disadvantage many attempts have been made to discover a mercurial compound which would fulfil the ideal therapeutic requirement; viz., to kill the spirochetæ by means of a single injection. The nearest approach to this was the discovery of atoxylate of mercury by Uhlenhuth and Manteufel. By using this drug they were able with four injections to kill all of the spirochetæ which were produced by local inoculation of the testicles in rabbits. Not only were four injections insufficient to have a like effect in man, but the doses required were much larger comparatively, and, as a result, toxic symptoms developed and recurrences were frequent; so atoxylate of mercury was never extensively employed. The discovery of this product, however, acted as a stimulus and spurred chemists on to further investigation.

It may seem strange to those who are more or less familiar with the drugs that have been employed in the treatment of syphilis that the latest specific for the disease is a compound of arsenic and not of mercury. The formula for '606' is $C_{12}H_{12}N_2O_2As_2$. Ehrlich claims that his discovery was due largely to the well-known fact that the compounds of arsenic exerted a far greater influence in sleeping sickness than did the compounds of mercury, and it was for this disease that atoxyl was discovered. When it was shown, in 1905, that syphilis was caused by the spirocheta pallida, a protozoön which doubtless belonged to the same group as the germ which produces sleeping sickness (trypanosomes); and since arsenic had often played an important rôle in the treatment of this disease, the later synthetic compounds discovered, of which atoxyl was the stimulus, came to be used for syphilis as well as for sleeping sickness.

Secondary Syphilis.—The manifestations of what is known as the *secondary symptoms* do not appear until from four to six weeks after the development of the hard chancre.

Diagnosis.—If no treatment has been instituted, eruptions on the skin usually mark the beginning of this stage, and, according to L. Blake Baldwin, eruptions are frequently found on the oral mucous membrane quite similar to those upon the skin. These eruptions are accompanied by fever, sometimes preceded by it. Simultaneously with the eruptions and fever characteristic *mucous patches* occur, and may be located on any part of the mucosa of the mouth, regardless of whether the disease originated primarily or secondarily in the mouth. (Fig. 193, *b*, and Fig. 194, *a*, *b*, and *c*.) The presence of mucous patches is a positive sign of syphilis. They differ from canker sores in that they have more clearly defined margins and are not so painful to the touch, and the immediate area is not of such a deep red color (Gilmer). The mucous patches are *exceedingly infectious*, and due caution should be observed not to carry the infection from one patient to another.

Therapeutics.—Inasmuch as secondary syphilis is manifested in the mouth and leaves its indelible effects upon the gums, jaws, and adjacent structures, mercury is the one drug indicated in its treatment, for this drug has a selective influence upon these structures. In fact, mercury is a *specific* for the secondary symptoms, though its action, as yet, rests purely upon an empirical basis. It is not even known whether the action of the drug here is due to specific toxicity for the spirocheta pallida or whether it is simply due to its general effects upon metabolism. The former, according to Sollmann, seems to be the case. Mercury is not only palliative, but curative in this stage—congenital as well as acquired—whilst its administration is worse than useless in the first and third stages.

The systemic treatment, of course, should be relegated to the family physician. Long[1] very properly emphasizes a word of caution here. He says: "It may fall to the dentist to discover a case of syphilis, by mouth symptoms, where it had not been suspected, but he must be exceedingly cautious about discussing this finding with the patient. He is dealing with a matter for which he has not been consulted, and in any suspicious acts or words of his lie the possibilities of much unpleasantness. If the patient be an innocent wife, a statement of his discovery might produce domestic discord. While she would have a most serious grievance, entitling her to our pity, a revelation could only add to her unhappiness. A suggestion

[1] Dental Materia Medica and Therapeutics, p. 206.

to her to see her family physician for certain general conditions that you find evidence of, would be the proper course; and even this advice must be given tactfully, without arousing suspicion as to the probabilities in the case, for, after all, a mistaken diagnosis is possible."

The preparations of mercury most frequently prescribed in syphilis are mercury with chalk, and compounds like bichlorid, biniodid, and protiodid. The ointments are used by inunction. None of these preparations should be pushed to the extent of producing ptyalism or salivation.

An accurate and positive diagnosis of syphilis should always be made before instituting the mercurial treatment, otherwise disastrous results are almost certain to follow. In a recent case of a little girl, seven years old, of doubtful syphilitic history, coming under the observation of the author, a sequestrum was removed which contained the erupted first permanent molar and the crowns of the non-erupted first and second bicuspids. The case terminated fatally.

Syphilographers have learned from sad experience that mercury can be pushed much farther without producing ptyalism, if the mouth has first received a thorough prophylactic treatment. This includes the removal of all local irritants, such as hard and soft deposits, overhanging fillings, ill-fitting crowns, and bridges. In fact, it is only when the mouth and teeth are clean that the symptoms of ptyalism are valuable as an index that the system is taking all the mercury it can absorb without producing marked toxic effects. If the teeth are not clean and the mucous membrane healthy, it is best to wait until the mouth receives proper attention before attempting to find the minimum toxic dose of the drug. On this point, White and Martin[1] state that "the teeth should be put in perfect order by a competent dentist, and should be kept scrupulously clean throughout the entire course of treatment by cleansing washes, astringent and mildly antiseptic powders (or pastes), and careful removal of particles of food by means of tooth-picks and dental floss immediately after eating. Upon the health of the mucous membrane of the mouth depends, to a great extent, the ability of the patient to take an efficient quantity of mercury without causing salivation."

Dentists in the past have hesitated to work for patients who were known to have the specific disease on account of the danger of self-infection, and the subsequent necessity of discarding all

[1] Genito-Urinary and Venereal Diseases, Ninth Edition, p. 1008.

instruments used. Logan[1] says: "These syphilitic individuals can be cared for with impunity if the operator protects his hands with rubber gloves and then scrubs all the instruments employed and boils them for fifteen minutes. If this plan is pursued, there is no need of such absurd action as is often recommended—that all such instruments should never be used again, but thrown away."

Tertiary Syphilis.—This condition may be prevented if proper treatment has been previously inaugurated. In cases not so treated the *tertiary symptoms* usually occur in from one-half to two years after infection.

Diagnosis.—*Gummata* mark the third stage of syphilis and first appear as hard bodies or nodes occurring mostly under the skin, although they may form under the mucosa of the mouth. They gradually increase in size, and become more superficial, with a tendency to break down and ulcerate. (Fig. 195, *a*.) When they occur in the region of the hard palate, the underlying bone frequently becomes involved and extensive necrosis of the palate and nasal bones follows. (Fig. 196.) Gilmer[2] states that subperiosteal gummata are especially destructive to bone, and reports having seen cases in which the soft palate also was completely destroyed from ulceration of gummata in that locality. Authorities differ in regard to whether the lesions of tertiary syphilis are infectious. It is believed by many that they are infectious, but less so than the secondary ones. It is well here also to guard against spreading possible infection.

Therapeutics.—The one drug indicated in the treatment of tertiary syphilis is the great alterative, potassium iodid. In this stage of the disease the efficacy of potassium iodid is equal to that of mercury in the secondary stage, and it may be considered a *specific*. The systemic treatment should be relegated again to the family physician. The initial dose of the drug should be small, and the amount gradually increased until improvement follows or symptoms of iodism appear. For permanent results it is necessary to continue the antisyphilitic treatment for from six months to a year or more.

The question of whether syphilis can be cured or not has been a debatable one in the past, but its cure is no longer questioned by experienced syphilographers. Yet it may be safely stated that few cases are ever permanently cured, for only a small percentage of patients will continue the treatment sufficiently long, after they feel perfectly well, to effect a permanent cure.

It should be remembered that syphilis stamps its indelible effects

[1] *Dental Review*, Vol. XXII, p. 813.
[2] *Dental Review*, Vol. XXIII, p. 498.

upon the individual thus afflicted in almost every case, and that any subsequent infection, like that in alveolar abscess or periodontoclasia, is likely to extensively involve the osseous structures, and yield to the ordinary treatment with difficulty. The author has previously referred to a case of extensive necrosis following slight trauma after the removal of a pulp by pressure anesthesia, where every due precaution was taken to maintain asepsis in performing the operation (see Fig. 105, p. 450).

In conclusion I desire here again to emphasize the fact that every dentist should so school himself in this dreadful disease that he may be able to at once recognize its various manifestations. When in doubt about a lesion in the mouth, it is always better for dentists to assume that it is specific in character, and take every due precaution against infecting themselves or their patients.

MERCURIAL STOMATITIS

Mercurial stomatitis is a condition of the mouth frequently following the administration of mercury and its compounds for the treatment of syphilis and other conditions. The drug is used for its alterative and tonic effects. As has been mentioned, it is a specific for secondary syphilis, and every dentist should be thoroughly familiar with the effects of this metal when taken internally.

Diagnosis.—When small doses of an unirritating preparation of the drug are given continuously for a certain length of time, the first effects are observed in the mouth, for it has a selective influence upon the gums, jaws, and adjacent structures. There is produced an increased flow of saliva, fetor of the breath, redness of the gum margins, and pericementitis, causing soreness of the teeth when the jaws are forcibly brought together. If the drug is not withdrawn upon the appearance of these symptoms, the condition gradually grows worse; salivation becomes excessive (continual drooling), the gums become swollen and spongy, the teeth loosen from their sockets and may be easily extracted with the fingers, the tongue and parotid glands enlarge—the former sometimes to the extent that it protrudes from the mouth; often there are deep sloughing ulcers made by indentations of the teeth upon its edges, also upon the mucous membrane of the cheeks; and, finally, the soft tissues around the teeth slough away, necrosis of the bones sets in, and large sequestra form. This group of symptoms is known as *ptyalism* or *salivation*. In these cases the general health is naturally affected, the patient becomes pale and loses flesh. Chronic mercurial poisoning occurs

frequently in workmen who handle the metal or who are exposed to its fumes, such as makers of thermometers, mirrors, scientific instruments, etc. The condition, however, is too frequently produced by the prolonged use of mercury as a medicine.

Therapeutics.—The treatment of mercurial stomatitis has been fully considered under Mercury (see p. 217).

TUBERCULOSIS

Tuberculosis is known as the "great white plague;" and it was not so many years ago that the disease was rapidly undermining the human race. In connection with its prevention it is interesting to know what is being accomplished by the National Tuberculosis Association. In the registration area of the United States, the death rate from tuberculosis in 1900 was 202 per 100,000; in 1910, 160; in 1920, 114; in 1922, 99. In the great metropolitan city of New York the decreased death rate is even more striking. From 280 deaths per 100,000 in 1900, it stands 99 in 1922. This vigorous antituberculosis campaign has blazed the trail for health workers in other fields (cancer, etc.), in the creation of special agencies for special types of diseases, in the application of corrective measures for the prevention of different diseases, and especially in directing attention to the significant fact that no campaign along this line will succeed unless it is general in character and has for its ultimate aim the improvement of individual health and the protection of public health. Millions of dollars are spent annually in the United States in fighting tuberculosis, $3,800,000 being collected by the National Tuberculosis Association in 1922 from the sale of Christmas Seals alone.[1]

The disease is caused by the *tubercle bacillus*. Brophy[2] says: "The tubercle bacillus may enter the body by several avenues. The inhalation method is the one most commonly met with. The sputum of consumptives contains vast numbers of the bacilli and the atmosphere immediately surrounding these patients, as well as the dust, is very infective. Those who contract tuberculosis by this method usually develop the pulmonary form of the disease or the bronchial glands become the seat of infection and other organs are involved from these. The tonsils also may be the seat of the primary lesion, as the crypts offer an excellent place for the growth of the tubercle bacillus. The glands of the neck may become secondarily involved, following infection of the tonsil." In this connection it may be

[1] Report "Nat'l Tuberculosis Ass'n," May, 1923.

[2] Oral Surgery, p. 67.

remembered that Cook, Moorehead, and others have reported cases where the *bacilli* have entered the system through the canals of pulpless teeth and pyorrheal pockets, involving the glands in the neighboring region.

The disease is occasionally seen on the mucosa of the mouth. Gilmer[1] reports having seen three cases, one of the tongue, one of the sublingual salivary gland, and one an extensive involvement, including a part of the lips, the mucosa of the cheek, the soft palate, the tongue, and a portion of the pharynx.

Diagnosis.—The microscope will aid in definitely determining tubercular lesions in the mouth, as well as in other parts of the body (Fig. 197). The tubercle is the characteristic lesion produced by the bacillus. It will be noticed that the ulcers arise from the confluence of numerous miliary tubercles. The ulcers are usually covered with yellowish-white pus.

Therapeutics.—The dentist may first discover the lesion and aid in making the diagnosis; but treatment had better be given by the general medical practitioner or specialist, for the cases are rare and no definite local treatment has thus far been permanently established. It may be stated, however, that various forms of light have been used in many cases with favorable results in tubercular and similar affections. Where there is bone involvement Beck reports surprising results from the injection of bismuth paste.

LEUCOPLAKIA BUCCALIS

Leucoplakia is a disease of the mouth and tongue, the etiology of which is as yet unknown. A large percentage of the cases of leucoplakia buccalis give a previous history of syphilis. It is, therefore, suspected that the latter disease has a causative relation to leucoplakia, though no definite evidence in this respect has been produced. Gilmer,[2] who has seen a large number of cases, is of this opinion. He says: "Many cases of leucoplakia buccalis have come under my observation, and, with few exceptions, I was able to elicit a history of syphilis."

Diagnosis.—The disease manifests itself upon the buccal mucosa, portions of the gums and the dorsum and edges of the tongue, and other places. There appear, sharply outlined, whitish or silver-colored points, streaks, bands, or patches of irregular shape, either flattened or slightly elevated above the level of the general mucosa.

[1] *Dental Review*, Vol. XXIII, p. 499.
[2] *Dental Review*, Vol XXIII, p. 500.

Ordinarily they simply present a roughened surface without much discomfort. They occur almost exclusively in the mouths of men who are excessive smokers. The condition, however, should not be mistaken for that which is frequently seen in the mouth of excessive smokers, especially pipe smokers, where there is a whitening of extensive areas of the tongue or hard palate or both. Gilmer[1] says: "The epithelium of the smoker's tongue is of a brownish-white, while in leucoplakia the patches are of a clear white color." Leucoplakia patches are very characteristic, no other condition of the mouth presents the same clinical picture. The affection is painless, and may be overlooked by the patient unless it becomes complicated with cancer (see Fig. 198).

Therapeutics.—It has been observed that carcinoma frequently has its beginning in the site of an old leucoplakia patch. Since this is true, an early diagnosis should be made, and the proper treatment instituted by the family physician. In cases of known syphilis the antisyphilitic treatment would be indicated. The general tendency of dentists in conditions of this kind is to use cauterants, such as silver nitrate. In the treatment of leucoplakia this should be avoided, as it only tends to aggravate the disease. Adams states that Balsam of Peru, applied several times a day and for as long a time as one can hold it in the mouth on lint or gauze, will cure leucoplakia. This is an interesting statement for dentists, who are among the first to recognize the disease.

ACTINOMYCOSIS

Actinomycosis is a common disease among the lower animals, especially cattle, and is known as *lumpy-jaw*, the disease affecting the lower jaw and cervical glands. Cases in the human being have been reported by Brophy, Bevan, Zederbaum, and others. It is produced by the ray-fungus, which is normally found in grain, and is supposed to find its way into the mouth from the habit of chewing straws. The germs gain admittance into the tissues from the mouth through decayed teeth.

Diagnosis.—The microscope affords a positive means of diagnosis. Blair[2] states that "the disease first manifests itself in the form of a small nodule, which for a time may give no trouble, but later softens and forms sinuses from which is discharged a thin fluid which usually contains the fungus."

[1] *Ibid.*

[2] Surgery and Diseases of the Mouth and Jaws, p. 304.

Therapeutics.—The treatment of the disease had better be carried on by the medical specialist, as it is so rare in the human being that dentists but seldom see the condition. Based on observations made at the Wisconsin Experimental Agricultural Station, Bevan introduced the copper sulphate treatment in man, and both he and Brophy report good results by using the drug to the limit of toleration. They begin with about ¼ gr. given three times a day, gradually increasing the dose to 1 gr. In addition to the internal administration of copper sulphate, irrigations of a 1 per cent. solution are also employed. Some authorities claim potassium iodid to be a specific for actinomycosis. The drug should be pushed and its use continued until a cure results.

ACUTE ULCEROUS GINGIVITIS

Acute ulcerous gingivitis until recently was considered a comparatively rare disease. The author, however, has seen a number of cases in the mouths of children coming to the College Infirmary for treatment from the so-called "slum districts" of Chicago. This may have been a coincidence, but I have never observed the typical disease in well-kept mouths. It may be regarded as a filth disease; and was prevalent among the soldiers in the late World War, and was known as "trench mouth." Tunnicliff found the bacillus fusiformis as the predominating organism in this disease. This germ is frequently found in other lesions. It may and often does grow symbiotically with other organisms.

Diagnosis.—Gilmer[1] well describes the disease as follows: "It attacks simultaneously the gum margins on their buccal or labial aspect about two, three, or possibly four teeth, at the same time. The ulcers come suddenly, quickly destroying the gingivæ down to the alveolar process, but seemingly not invading it, exposing the roots of the teeth to this extent. The margins of the ulcers are everted, crater-like, somewhat like chancrous ulcers. The base of the ulcers is overlaid with a grayish-white covering. When this covering is removed, the granulating surface bleeds freely. The lymphatics related to the area become enlarged, and, unlike chancrous lymphatic enlargements, are tender. It is also unlike chancre in that the ulcers are nearly always multiple and, exceedingly painful to touch. Salivation is much increased, with frequent drooling, the breath is fetid, and, owing to the absorption of toxic elements, there is a slight rise in temperature. The contiguous lingual gingivæ become reddened, but do

[1] *Dental Review*, Vol. XXIII, p. 501.

not participate in the ulceration. The condition has been mistaken for syphilis."

Therapeutics.—The ordinary local remedies used for somewhat similar conditions are of little value here unless systemic treatment is simultaneously instituted. Calomel is the drug to give internally, a prescription for which follows:

℞—Hydrargyri chloridi mitis, gr. ij (0.13 Gm.)
Sodii bicarbonatis, ʒj (4.0 Gm.)—M.
Fiat chartulæ No. xx.

Sig.—Take one powder every two or three hours.

The local treatment consists in cleansing the ulcer with such agents as hydrogen dioxid, drying the part and applying a 10 per cent. solution of silver nitrate or a 20 per cent. solution of argyrol. A 5 per cent. solution of dichloramin-T may also be used, observing the usual precautions in using this drug. If the ulceration is checked, complete restoration of the gum tissue by granulation follows. Mouth hygiene should, of course, be instituted and strenuously carried out.

A form of ulcerous gingivitis, somewhat resembling the above condition, frequently occurs in the mouths of young people, especially young men who are addicted to the habit of smoking. The gum in the interproximal space first is reddened, this being quickly followed by necrosis which extends around the teeth. The gingiva of all the teeth in the mouth may be simultaneously involved. The disease is exceedingly painful, is sometimes accompanied by fever and loss of flesh, and, by the dentist who called almost every disease of the mouth periodontoclasia, patients, thus afflicted, have frequently been informed that they were suffering from the latter disease. Generally in these cases the teeth have been neglected, so far as prophylaxis is concerned, and an irritant of some character will be found about the necks of the teeth or under the free margin of the gums. This is about the only symptom that the disease has in common with periodontoclasia. In these and all such similar cases the highly astringent pyorrheal remedies should not be employed. What is needed here is a thorough prophylactic treatment, the local application of mildly stimulating remedies, such as a 25 per cent. solution of argyrol, and the daily use of an antiseptic mouth wash. If necessary, a cathartic should be prescribed. With the above treatment these disagreeable cases yield nicely.

VINCENT'S ANGINA

Vincent's angina or **Vincent's infection** is an infection of the oral mucous membrane which manifests itself in the mouth and adjacent structures in various clinical forms, types and appearances. On the tonsils and posterior palate it appears as a deep ulceration; on the ramus of the mandible posterior to the last molar, as a localized ulcerating patch; as a general infection, it frequently involves the entire mucosa and at times the tongue, or it may remain limited to the gums. The disease is caused by the rapid growth of the bacillus fusiformis and Vincent's spirillum (spirochete). The bacillus and the spirochete have been found in the mouth as a saprophyte; and some bacteriologists have succeeded in cultivating the bacillus as an anaerobe. Many organisms only become pathogenic under certain favorable circumstances. This is no doubt true of the bacillus fusiformis.

Diagnosis.—The affection is characterized by the formation of ulcers covered with a grayish-white membrane, formed by a necrosis of the superficial layers of the mucous membrane. This typical appearance, however, is not always present, owing to the different locations in the mouth and the varying forms in which the disease is manifested. The patches or ulcers are surrounded by a red zone, but separated from each other by healthy tissue. Removal of the membrane shows an ulcer of varying depth, which bleeds freely and is sensitive. The membrane is soon reproduced. The infection is often limited to one side. If extensive, there is swelling of the lymph nodes, salivation, fetor, an increased pulse, and fever from the absorption of toxic products. As a rule, however, the infection rarely causes marked constitutional disturbances.

Therapeutics.—The remedies which have been suggested for the treatment of Vincent's infection in recent years have been many and varied. The disease is no longer considered rare. Its response to treatment is sometimes slow and discouraging. In connection with the therapeutics, it should be noted that under ordinary conditions the bacillus fusiformis is not destructive. It is a saprophyte and grows only on dead and dying tissue. But when the organism is found in association with the streptococcus and staphylococcus enough tissue is destroyed by these germs to afford a proper habitat for the bacillus fusiformis; and in such an environment its growth becomes very active and it is very pathogenic. Its lack of power to penetrate living tissue to any appreciable depth, makes its eradication by proper local medication all the more easy. Drugs, therefore, which destroy tissue are contraindicated.

Dakin's solutions (Chloramin-T and Dichloramin-T) and sodium perborate are without doubt the most valuable remedies to use in the treatment of this disease. The use of Dakin's solutions has been elsewhere fully explained (p. 79). In using sodium perborate, not only should the drug itself be pure and fresh, but the solution should be made at the time of use from such a specimen. The pure drug should contain not less than 9 per cent. of available oxygen. The membrane should be removed from the ulcer and sodium perborate dusted on the raw and bleeding surface. A 2 or 3 per cent. solution may be prescribed as a mouth wash, instructing the patient how to make such a solution at the time of use (teaspoonful in one-half glass of warm water). Dr. Henri Letord, a dentist of El Paso, Texas, is credited with being the first to bring the use of this drug before the attention of the medical and dental professions. Mengel, Smeltzer and others claim remarkable results in treating Vincent's infection with sodium perborate.

A 20 per cent. solution of argyrol is always useful in treating such conditions; and the local application of one of the basic analine dyes, methyl blue or violet, applied dry in a cotton swab daily is claimed to effect a cure in a few days. Whatever drug or remedy is used topically on the ulcer, an alkaline and antiseptic mouth wash should always be prescribed. As the disease occurs in locations where the parts are not kept clean, it is essential in the treatment that all carious teeth should be filled as soon as possible; and such teeth as are hopelessly involved, either from this disease or from any other cause, should be removed. It should be remembered that no teeth are to be removed, however loose, until the acute symptoms of the infection have subsided and the disease is well under control. Grave results may follow the neglect of this precaution. Cleanliness is of first importance; and a thorough prophylactic treatment should be given.

CASES FROM PRACTICE OF DR. GEO. H. MENGEL, EL PASO, TEXAS

Series No. 1

Patient.—Male. Age, 18. Vincent's infection, positive. The septal gingiva between lower right first and second molars presented the mouth of a sinus, caused by the infection entering distally of third molar. The pus had burrowed forward to the first bicuspid, one centimeter below the gum margin. Fig. 199, shows septal gingivæ of the upper incisors before treatment. Fig. 200, shows

septal gingivæ of the lower incisors before treatment. Fig. 201, shows both upper and lower eight months after treatment.

Series No. 2

Patient.—Male. Age, 18. Vincent's infection, positive. Fig. 202, shows large tumefied septal gingivæ, typical of chronic non-ulcerative Vincent's infection. Pressure caused bleeding of septal gingivæ. Fig. 203, shows decided improvement after incomplete treatment, the latter due to lack of cooperation on part of patient.

Series No. 3

Patient.—Female. Age, 11. Vincent's infection, positive. The father of this patient had chronic Vincent's infection. Figs. 204 and 205, shows the rounded, tumefied, glistening gums, typical of the disease.

LUDWIG'S ANGINA

Ludwig's angina is an acute infection of the floor of the mouth. Starting from a surface focus, usually within the mouth and insignificant, a severe infection passes to the submaxillary lymph nodes, where it takes on virulent activity, leading to an extensive cellulitis and producing a very hard, tumor-like mass between the borders of the mandible. The edema frequently extends to the larynx, alarming the patient because of the difficulty in breathing. In this disease the streptococcus seems to be the active organism, and is associated again here with the bacillus fusiformis.

Diagnosis.—The manifestation of the above described symptoms would lead to but one conclusion—Ludwig's angina. According to Hofheinz, the symptoms as outlined by Ludwig have never been questioned, though their cause has been much disputed. As a rule, there is very little constitutional disturbance. Ptyalism may be produced. The tongue is not sensitive, but its movement causes pain.

Therapeutics.—The treatment of this disease had better be undertaken by an oral specialist. Drainage must be established. The mouth should be irrigated every two hours while the patient is awake with a warm antiseptic solution, and Brophy advises painting the throat with a 10 per cent. solution of iodin in glycerin. This author also warns us against the extraction of a tooth which may have started the infection until, at least, the acute stage has passed.

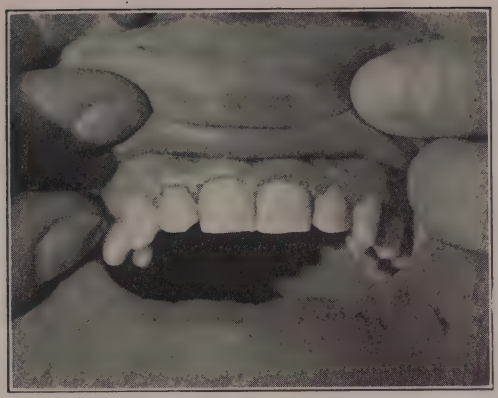


Fig. 199.

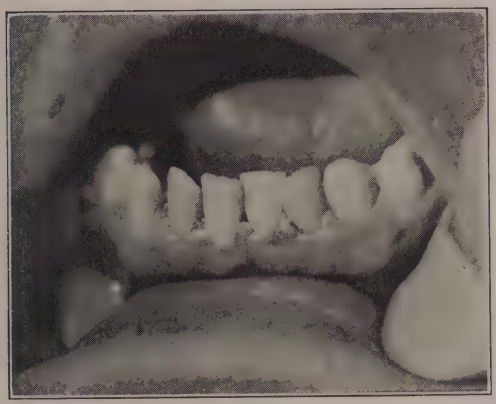


Fig. 200.

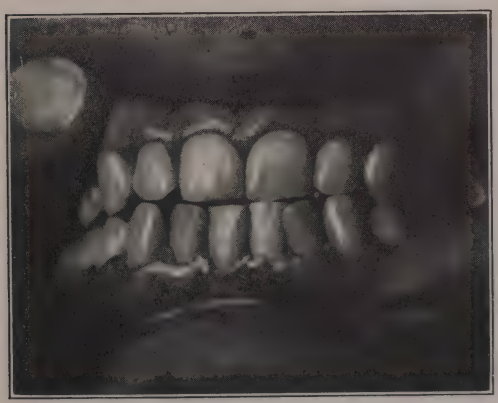


Fig. 201.

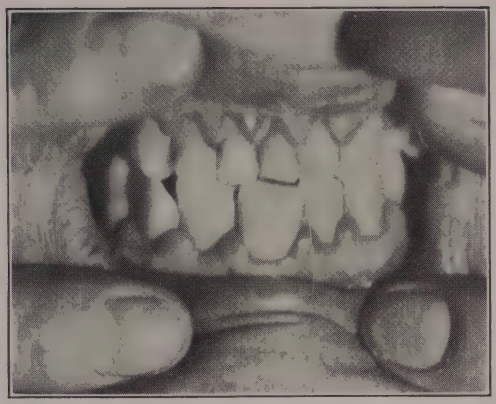


FIG. 202.

FIG. 203.

FIG. 204.

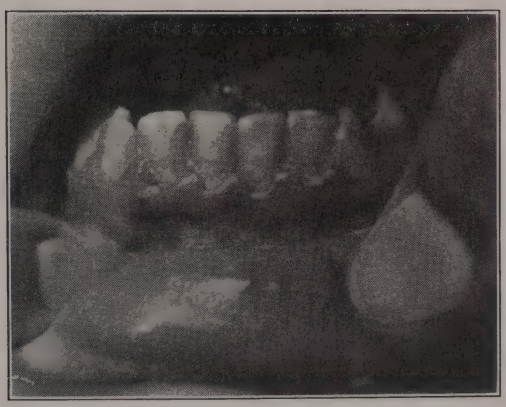


FIG. 205.

GONORRHEA

According to Burchard-Inglis, undoubted cases of oral infection by the specific germ of gonorrhea (*gonococcus*) have occurred. The author has seen at least one such case. The mucosa of the cheeks, gums, tongue, and even of the hard and soft palates may undergo intense suppuration. Mouth hygiene and the systemic treatment of the constitutional trouble cure the case.

There are a variety of neoplasms and other diseases which manifest themselves in the mouth, involving both the soft and osseous structures, for the diagnosis and treatment of which see works on Oral Pathology and Surgery. The more common of the diseases of the soft tissues of the mouth and their treatment have been thus briefly considered here with the hope of stimulating a greater interest in this phase of mouth diseases.

In this relation it may be stated that in recent years the attention of both the medical and dental professions has been focused on the subject of cancer. The prevalency of this disease today is of an alarming character. It has been estimated by those in a position to know that more people now living over forty years of age will die of cancer than from any other single cause; and the death rate is increasing about 2.5 per cent. annually. One man out of every thirteen and one woman out of every eight past this age will succumb to some form of malignant neoplasms; and since a fair percentage of these growths occur on the lips, cheeks, tongue, jaws, and pharynx, a knowledge of precancerous lesions in and about the mouth is of the utmost importance to every practicing dentist. Recognized in its incipiency cancer can, in large measure, be prevented or cured. The death rate from cancer is found to be highest in the most advanced communities and lowest in the most backward, not because "cancer is a disease of civilization," but because in the former localities the statistics come nearer reflecting the facts—due to an opportunity for a more intense effort at diagnosis on the part of physicians and dentists. The reader is referred to "Index of Dental Literature" for interesting articles on cancer by Bloodgood, Crile, Logan, and others.

EXAMINATION OF URINE[1]

1. THE SAMPLE.—That passed on arising in the morning.

2. QUANTITY.—In 24 hours = 1,000 to 1,500 cc.

3. CONDITION.—Clear or sedimentary.[2] Filter, if sedimentary, and examine color.

4. COLOR.—Pale yellow, yellow (normal). Reddish yellow (bile coloring). Blood red (excess of urates). Reddish brown (breaking up of blood-corpuscles).

5. CONSISTENCY.—Thin (normal). Thick, syrupy or stringy (indication of sugar, albumen, pus or fibrin).

6. REACTION.—By litmus paper. Mild red (slightly acid, normal). Neutral or alkaline (inflammatory condition of urinary tract).

7. SPECIFIC GRAVITY.—With urinometer. 1,015 to 1,025 (normal), 1,015 or below (excess of water) 1,030 or above (excess of solids —urea or sugar).

8. ALBUMEN.—(1) Heat Test.—Pour urine in a test-tube to 2 in. in depth. Boil gently, heating from top downward. If a precipitate is formed it is either (a) earthy phosphates (soluble in acetic acid), (b) albumen (insoluble in acetic acid). (2) Nitric Acid Test.—To 2 in. of urine in a test-tube, held slantingly, add five to ten drops of concentrated nitric acid, c. p., permitting it to run carefully down the side of the slanting test-tube. A white coagulum at the zone of contact of the two liquids indicates albumen. To eliminate error, both the heat and nitric acid tests should be made.

9. TOTAL SOLIDS.—Multiply the last two figures of the sp. gr., if it is below, 1,018, by 2, the coefficient of Trapp. If above 1,018 by 2.33, the coefficient of Haser. This gives the total solids in 1,000 cc. As the quantity of urine passed in twenty-four hours is about 1,500 cc., the above result should be multiplied by 1½, which will give the total solids for twenty-four hours.

[1] This outline was condensed by Professor J. N. Roe, whom the author assisted for several years in the Chemic Laboratories of the Chicago College of Dental Surgery.

[2] Set sample of urine aside in a conical glass and examine the sediment with a microscope.

TOTAL SOLIDS IN NORMAL URINE

EXCRETED IN TWENTY-FOUR HOURS

Constituents	Grams
Total Solids	60.0 to 70.0
Urea	*30.0* to *40.0*
Uric Acid	0.4 to 0.8
Creatinin	0.5 to 1.0
Hippuric Acid	0.3 to 1.0
Chlorids	*10.0* to *18.0*
Earthy Phosphates	0.9 to 1.3
Alkaline Phosphates	2.5 to 3.5
Sulphates	1.5 to 2.5

10. UREA.—If the urine is above sp. gr. 1,025, test as follows:

Pour exactly 2 in. in depth of urine into a test-tube, and concentrate just one-half by boiling gently in the test-tube, or by pouring into a porcelain dish and concentrating over water bath, sand bath or wire gauze.

Pour the concentrated urine back into the same test-tube and ascertain if it is concentrated to exactly one-half the original volume. Introduce one-third volume of concentrated nitric acid, c. p. (free from red or yellow fumes). Place the test-tube and contents in a vessel of cold water.

A precipitate of Urea Nitrate is formed.
- *a. Immediately* (very copious, filling the entire volume of liquid). *Excess.*
- *b. After twenty minutes* (not heavy). *Normal.*
- *c. Not after several hours. Decrease.*

11. URATES.—Pour 2 in. of urine into a test tube, add fifteen to twenty drops of concentrated hydrochloric acid. Allow the mixture to stand twelve to twenty-four hours. The urates will be decomposed, and red crystals of uric acid (corresponding to brick-dust deposit) will collect in the bottom and on the sides of the tube.

The crystals on the sides of the tube may be loosened with a little stick or glass rod, when they will rapidly settle at the bottom.

The Uric Acid precipitate is,
- *a.* Copious (covering bottom of tube). *Excess.*
- *b.* Moderate (total bulk size one-half grain of wheat). *Normal*
- *c.* Very slight. *Decrease.*

12. CHLORIDS.—To 2 in. of urine in a test-tube, add five to ten drops of nitric acid and solution silver nitrate by drops as long as

any precipitate forms; shake slightly and set aside for a few moments to settle.

The Silver Chlorid precipitate is,
- *a. Copious* (over ½ in. in depth). *Excess.*
- *b. Moderate* (½ in. in depth). *Normal.*
- *c. Slight* (less than above). *Decrease.*

13. Sulphates.—To 2 in. of urine in a test-tube, add five to ten drops of hydrochloric acid, c. p., and solution of barium chlorid by drops as long as any precipitate forms; set aside and allow to settle.

The Barium Sulphate precipitate is,
- *a. Copious* (over ⅛ in. in depth). *Excess.*
- *b. Moderate* (⅛ in. in depth). *Normal.*
- *c. Slight* (less than above). *Decrease.*

14. Earthy Phosphates.—To 2 in. urine in a test-tube, add ammonium hydroxid until it smells strongly of ammonia; heat gently and set aside.

The Ammonio-Magnesium and Calcium Phosphates are,
- *a. Copious* (over ⅜ in. in depth). *Excess.*
- *b. Moderate* (⅜ in. in depth). *Normal.*
- *c. Slight* (less than above). *Decrease.*

15. Alkaline Phosphates.—Filter the liquid from No. 14 into a clean test-tube (or prepare another specimen as above and filter), add ten drops of ammonium chlorid and magnesium sulphate by drops as long as any precipitate is formed. Heat gently and set aside to settle.

The Ammonio-Magnesium Phosphate precipitate is,
- *a. Copious* (over 1⅛ in. in depth). *Excess.*
- *b. Moderate* (1⅛ in. in depth). *Normal.*
- *c. Slight* (less than above). *Decrease.*

16. Sugar.—Remove any trace of albumen or earthy phosphates by boiling and filtering. Use the clear filtrate. Pour into a test-tube 1 in. of Fehling's solution and add same quantity of water. Boil gently. If precipitate is formed, filter; when, after repeated boiling and filtering, no precipitate is formed, add urine and heat as before.

No change in color = No sugar.
Slight change to dirty green = Trace of sugar.
Bright yellow = Sugar over 1 per cent.
Red = Excess of sugar.

In case it is desired to have a microscopic and bacteriologic examination of the urine, the specimen may be sent to a Pathologic

Laboratory, these are now in every large city. But every dentist should be prepared to make physical and chemic examinations, according to the outline here given. The results of the analysis should be recorded and preserved. This may be done in the following form:

URINE ANALYSIS

Name,_____.
Date,_____.

Physical Characters.

Amoiunt in 24 hours,_____.
Specfic gravity,_____.
Condition,_____.
Color,_____.
Consistency,_____.

Chemic Characters.

Reaction with litmus,_____.
Reaction with heat,_____.
Reaction with nitric acid,_____.
Total solids,_____.
Urea,_____.
Urates,_____.
Chlorids,_____.
Sulphates,_____.
Earthy phosphates,_____.
Alkaline phosphates,_____.
Abnormal constituents.
Albumin,_____.
Sugar,_____.

Clinical Memoranda.

FEHLING'S SOLUTION

Fehling's Solution is made by mixing exactly equal volumes of the below-mentioned copper solution and alkaline solution at the time required.

Copper Solution:

Crystallized copper sulphate,	34.64 Gm.
Sterilized distilled water, sufficient quantity to make	500.0 cc..

Alkaline Solution:

Potassium and sodium tartrate (Rochelle salt),	173.0 Gm.
Potassium hydroxid,	125.0 Gm.
Sterilized distilled water, sufficient quantity to make	500.0 cc.

These solutions should be kept in well-stoppered bottles, in a cool, dark place, and mixed only at the time needed. If a precipitate forms when the cold solutions are first mixed, it should be dissolved by agitating the test-tube; and no precipitate should form when the mixed solutions are heated. By keeping the copper solution and alkaline solution in separate bottles in a cool, dark place, they should keep without change almost indefinitely; however, it is best to have fresh solutions prepared at least once a year.

GENERAL INDEX

ABDERHALDEN on inorganic iron, 204
Abrasions, 156, 166, 348, 350
Abscess alveolar, acute, 124, 127, 166, 180, 216, 243, 399, 439
chronic, 111, 441
between roots, 468
caries in, 451
caused by toothpick, 470
cavity, 63
dental, early treatment of, 423
dento-alveolar, 71, 72, 96
drainage of, 440
due to blow, 469
in deciduous teeth, 466
involving several teeth, 453
lancing of, 143, 159, 161
of both antrums, 349
of frontal sinus, 349
pericemental, 468, 470
pocket, secondary, 453
pulpal, 354, 416
rupture of, 419
treatment of, 216, 243, 442
by ionization, 406
with sinus, 445, 448
without sinus, 442, 448, 449
Absorbent cotton, 24
Absorption of drugs, 25
of bone, 441
of toxins, 502, 503
Abstracts, 17, 18
Acacia, 137
Acetanilid, 165, 166
powder, effect of, on heart, 191
prescriptions for, 438
Acetic acid, 113, 390
Acetone, 189
Acetozone, 106, 489, 494
Acetphenetidin, 166, 180, 536
Acetyl-paramino-phenyl salicylate, 53
Acetyl-salicylic, 52
Acid, acetic, 113, 390, 489
amido, 395
benzoic, 35
boric, 35
cambogic, 245
citric, 222
gallic, 39, 87
hydrochloric, 112
hydrocyanic, 199
hydrofluoric, 121
lactic, 114
"method," 403
mineral, 37
monochloracetic, 114
Acid, nitric, 111
oleic, 14
osmic, 37
oxalic, 107
phenolsulphonic, 110, 402
phosphoric, dilute, 211
salicylic, 51
sulphuric, 109, 365, 399, 402, 403
sulphurous, 35, 36, 108, 238
tannic, 35, 85, 86, 379
treatment, 111
trichloracetic, 37, 113, 334
Acids, organic, 6, 513
Acne, 105, 260, 296
Aconite, 129, 434
poisoning, 130, 434
Aconitina, 129
Actinomycosis, 551
treatment of, 94, 216, 552
Active principles of drugs, 5, 18
Adenitis, 223
Administration of drugs, 33
Adrenalin chlorid combined with procain, 154
Adrenalin, 90, 195
chlorid for hemorrhage, 372, 457
objections to, 373
combined with cocain, 151
Age a factor in dosage, 32, 178
Agglutinins, 273, 274
Air, compressed, in dentistry, 295, 332, 334
purifier, 105
Air-thrombosis, 27
Albolin, 136
Albumin, coagulation of, 67, 70
decomposition of, 389
in urine, 558
Alcohol, abuse of, in dentistry, 345
as antiseptic, 189
as disinfectant, 325
dehydrated, 186
diluted, 186
for relief of pain, 439
modified, 189, 325, 345, 405
official standard for, 186
physiological action of, 187
therapeutics of, 189
Alcoholism, acute, differentiation of, 187
chronic, 188
Alcresta ipecac in periodontoclasia, 523, 524
tablets, 257
Alkali-metals, 119
Alkalies, poisoning by, 113

Alkaline powder, 42
solution, 561
Alkaloids as medicines, 6
Allspice, 264
Aloes, Barbadoes and Socotrine, 235
Aloin, 235
Alpha-Betamin, 289, 290
Alpha-eucain, 154
Alphozone, 106, 489, 494
Alteratives, 34, 203, 229, 250
Alum, ammonium, 92
potassium, 92, 255
Aluminum chlorid as a bleacher, 489
silicate hydrated, 43, 141, 523
Alveolar abscess, acute, 124, 435
extraction of tooth in, 439
treatment of, by magnesium citrate, 243
by potassium iodid, 216
chronic, 111, 441, 467
bone involvement in, 451
complications of, 444, 449, 462, 495
evacuation of pus from, 449
involving vault, 453
necrosis in, 451
sequelæ of, 454
sinus in, 114, 445
treatment of, 443, 445, 462
surgical, 454
diagnosed by radiograph, 403
external opening of, 445
from broken toothpick, 470
process, exfoliation of, 376
curettement, 517
exposed after extraction, 156
hypertrophy of, 445
removal of, 457
resorption of, 448, 506
purulent, 407, 442, 446, 495
without sinus, 442
Amalgam fillings, 219, 351, 458, 487
Ameba, pathogenic, diseases due to, 258
Amebæ in pyorrheal pockets, 257, 522
Amebæ in pyorrheal pockets, 522
Amido-acids, 390, 395, 441
Ammonia, 3, 190
as heart stimulant, 148
gas in pulp decomposition, 392
physiologic action of, 191
poisoning, 191
Ammonio-magnesium and calcium phosphates, 560
phosphate precipitate, 560
Ammonium acetate, solution of, 255
bromid, 175
carbonate, 191
chlorid, 259
hydrogen fluorid, 522
iodid, 216
Amputation of root-end, 521
Amygdalin, 199
Amylopsin, 230
Amyl nitrite, poisoning by, 195
therapeutics of, 195
Amytal, 173, 180, 338, 537
Analgentum, 63, 116, 384, 460
Analgesics, 34, 142, 337, 536
Analgentum, 58, 388
Analgesics, 34, 142, 337
Anchorage for filling, 363
occlusal, 346
Anemia, iron in, 204, 205
and neuralgia, 531
pernicious, 226
Anesthesia, advocates of, 330
cocain, 146
conduction, 29, 146, 154, 335, 499
discovery of, 329
high-pressure, 335
infiltration, 28, 383
interosseous, 28, 335
local, 26, 28, 146
oxid-oxygen, 421
pressure, 28, 152, 364, 367, 368, 430
prolonged, 159
tranquil, 181
Anesthesin, 157
Anesthetics, 34, 142
care in administering, 339
for curetting abscess area, 456
general, 142, 158
local, 142, 153, 335
safest, 158
Anesthetization by cataphoresis, 373
in removal of pulp, 364
solution, 366
under pressure, 368
Aneurysm, contraindications in, 195
Angina, Ludwig's, 554
pectoris, 225
Anhydremic patient, 241
Animal tissue, action of thymol on, 60
chemistry of, 387
Anise, 264
Anisotonic solution, 241
Anodynes, 34, 335
general, 337
in pulp removal, 372
local, 142, 335
Antacids, 34, 120
in oral prophylaxis, 40
Antagonism of drugs, 34, 321
Anthelmintics, 34
Antibodies, 271, 272, 299, 442
Antibodies, 271, 272, 299
Antidote for arsenic, 43, 117, 207, 208, 378
for digitalis, 194
for gelsemium, 202
for hydrofluoric acid, 121
for iodin poisoning, 134
for mineral poisons, 40, 112
for opium poisoning, 179
for phenol, 189, 447
for phosphorus, 210
for silver nitrate, 101
for strychnin poisoning, 185
in corrosive poisoning, 121
physiologic, 321
Antimony and potassium tartrate, 258
Anti-Narcotic Law, 149, 152, 180
Antipyretics, 35, 164, 166, 179, 255
Antipyrin, action of, 164, 165, 536
Antirachitic vitamin, 280, 285
Antiscorbutic vitamin, 285

Antisepsis in canal filling, 473, 536
of mouth, throat, nose, 76
Antiseptics, 35, 45, 189, 220, 316, 359, 405, 446, 450
Antispasmodics, 35, 160, 254
Antitoxins, 5, 272, 299
unit of, 272, 273
Antral cavity, washing of, 499
Antrum, abscess of, 452, 454, 461
diseases of, 495, 497
diagnosis, 497
due to trauma, 497
from catarrhal inflammation, 497
from dental conditions, 495
treatment of, by rhinologist, 498
medicinal, 499
surgical, 498
foreign bodies in, 296, 497
healthy, importance of, 498
of Highmore, 495, 499
opening of, painless, 499
Apexotomy, 458
Aphthous sore mouth, 101
Apicoectomy, 458, 462, 476
Apomorphin, 6
hydrochlorid, 256
Apoplexy distinguished from alcoholism, 187, 244
Apothecaries' weight, 301, 302
Appendicitis due to periodontoclasia, 504
Appetite, 198, 214
Appliances for loose teeth, 527, 528
for replanted teeth, 521
Argento-proteinum forte, 102
mild, 102
Argentum, 99
Argyria, 100
Argyrol, 101, 499, 541, 553, 555
Aristol, 62, 359
Arnica, 67
Aromatic spirit of ammonia, 190
waters, 9
Arsenic albuminate, 378
as escharotic, 115
compound, as specific for syphilis, 544
compounds of, 224
poisonous action of, 116
metallic, 224
poisoning by, 63, 116, 208, 376
acute and chronic, 117
local, 3, 116
systemic, 117
preparations of, 225, 376
toleration for, in Austria, 115
trioxid, 114, 225
a cause of pericementitis, 430
application of, 377
as an escharotic, 109
as devitalizing agent, 374
in densitizing, 330
poisoning, local 383
white, 114
Arsenical pigments, inhalation of, 116
Arsenous acid, 114
Arsphenamin, 226
Arterial hyperemia, 353
pressure reduced by paraldehyd, 173
Arthritis, 271, 507
chronic, treatment of, by vaccines, 275
Artificial respiration, Sylvester's Method, 148, 179
Asepsis, 45
absolute, in operation, 432, 455
in pulp removal, 371, 378
in root-canal work, 189, 473
Asphyxia from ether, 160
prevention of, 170
Aspirin, promiscuous use of, 52
Aspirol, 190
Assay of drugs, 16, 18
Assaying, indicator in, 239
Asthma, inhalations of niter in, 251
Astringents, 35, 84
mineral, 85
periodontoclasia, 514, 515
vegetable, 85
Atropin, 181, 197, 198, 253
poisoning by, 198
Aurantium, 266
Avoirdupois weight, 301, 302

BACILLUS diphtheriæ, 270
fusiform, 502, 550, 554, 556
tetani, 271
tubercle, 549
Bacteria a cause of pericementitis, 429
action of alcohol upon, 188
cultures of, 273
destruction of, 47, 322
entrance of, into body, 270
in mouth, 355, 540
in pyorrheal pocket, 501
multiplication of, 502
toxicity to, 72
Bacterins, 274
Bacteriolysins, 273
Bacteriotropins, 273
Balsam of Peru, 50, 551
Band, fitting of, 415
Bandages, 24
Barium sulphate precipitate, 560
Baths, Russian and Turkish, 293
Bay-rum, 264
Beck's paste, 99
compressed air apparatus, 332
Belladonna, 181, 197
action of, physiologic, 198
liniment, 15, 198
Benzocain, 157
Benzoic acid, 50, 516
Benzosulphinid, 268
Benzoylacetyl dioxid, 106
Berberin, 89
Beri-beri, 280
Beta-eucain, hydrochlorid, 153
Betanaphthol, 64
Bichlorid of mercury, 221
tablets, 21
Bicuspid, second, excementosed, 417
"Biliousness," 220, 247
Biologic processes, 5
products, 270

Bismuth paste, 99, 459
in antral disease, 499
healing of wound over, 451
poisoning, 99
subnitrate, 98
Bitter tonics, 198
Black copper oxid, 95
Black's 1-2-3 mixture, 56
Black mustard, 124
Black pepper, 262
Blaud's pills, 207
Bleachers, 35, 102, 239
Bleaching agents, 481
of teeth, 76, 103, 105, 108, 113, 212, 485
applications for, 108, 490, 491, 493
by oxidation, 103, 489
by reduction, 103, 490
principles of, 485
Blindness in United States, 100, 280
Blood, abnormal substances in, 531
coagulability of, 98
count in periodontoclasia, 503
corpuscles, white, action of quinin on, 437
deficiency of water in, 240
hemoglobin of, 203
-pressure, action of digitalis on, 193
relief of, 196
removal of, 369
-serum, salinity of, 240
substitute for, 200
stream, bacteria in, 270, 503
vessels, pulpal, 345
Blue light, treatment by, 295, 333
Boils, 143, 229
Bone cell stimulant, 404
condensation of, 393
phosphate, 211
pus formation in, 453
rarefaction of, 393
regeneration of, 421, 465, 470
removal of, by mallet, 457
tissue, loss of, 137, 465
Bones, action of phosphorus on, 209
Boracic acid, 47, 490, 499, 516, 542
Borax, 42, 43, 47, 49, 490
Boric acid, 47
Borism, 48
Boroglycerin, glycerite of, 133
Brandy, 148
Breath, fighting for, 146
Bridge and retainer, combination, 577
inlay, decay under, 420
Bridgework, 341, 349, 530
Brilliant green and crystal violet, 414
Broach, broken, 296
selection of, 369
Bromids, the, 174
as analgesics, 338
Bromism, 174
Bronchial catarrh, 58, 259
Bronchitis, acute, 250
chronic, 216
terebine in, 127
Brown mixture, 15
Brucin, action of, 183
Bruises, treatment of, 67, 88, 136, 162
Brushing of teeth, 515
Bunge on organic iron, 204
"Burning" process, 401
Burns from hydrofluoric acid, 522
treatment of, 41, 42, 66, 97, 134, 136, 166
Butyl-chloral hydrate, 171, 537

CACAO-BUTTER, 145
Caffein, action of, 193
as diuretic, 247
Calcific deposits, 63, 363, 381, 502, 511
Calcification of pulp, 296, 381
Calcium carbonate, precipitated, 40
chlorid, 98
deficiency, 213
hydroxid, 41
hypophosphite, 213
lactate, 212
phosphate, effect of, on nutrition, 213
paste, 57, 492
precipitated, 212, 358
thymolized, 358, 466
sulphurated, 228
Calculus, serumal, 504
Calendula and calendulin, 66
Callahan's method, 111, 403
rosin solution, 127, 477
Calomel, action of, physiologic, 220, 553
idiosyncrasy, 31
incompatability of, 221
Cameron lamp, 498
Camphor, 130, 131
Camphors, derivation of, 7
Canadin, 89
Canals, blocking of, 406, 417
exposure of, 368, 378
filling of, 127, 372, 455, 475
gangrenous, 114, 399
moistening of, 401, 473
obliteration of, 349, 381, 534
preparation of, for filling, 386
removal of blood from, 370
small and tortuous, 371, 476
Cancellous bone, 393
Cancer of stomach, 230
general remarks on, 557
of tongue, 77
superficial, 297
Cancrum oris, 95
Cane-sugar, 268
Canker sores, 57, 71, 76, 94, 114, 206, 541
differentiated from mucous patches, 545
Cannabis 181
storing of, 10
Cantharides and cantharidin, 128
Capillaries, depletion of, 437
Capillary attraction, absorption by, 132
oozing, 164, 189
Capping of pulp, 213, 354
Capsicin and capsicum, 124
Capsicum, oleoresin of, 19
Capsules, 237, 316, 438
Caraway 265

Carbohydrates as medicines, 6
in tissue, 388
Carbon, 5, 66
dioxid, evolution of, 112, 390
in drugs, 5
Carborundum stones, 513, 514
Carbuncles, 229
Carcinoma on leucoplakia patch, 551
Cardamom seed, 263
Cargentos, 102
Caries, dental, 111, 210, 268, 363, 451, 467
exploration for, 453
of bone, 458
removal of, 112, 357
Carlsbad salt, artificial, 242
Carminatives, 35, 261
Carr instruments, 509
Carron oil, 41, 135
Cascara sagrada, 233
Cases, history and treatment of, 416
from Mengel, 555, 556
Castings, 528
Castor oil, 236, 237, 538
Cataphoresis, 29, 297, 333
in pulp removal, 373
Catarrh, chronic, 41, 90, 99
Cathartics, 35, 232, 247, 553
saline, 239, 241
Caustic, lunar, 99
potash, 120
pyrozone, 105, 469, 492, 494
as a bleacher, 492
as an escharotic, 494
soda, 120, 490, 492
Caustics, 37, 109, 225, 333
desensitizing, 333
for bleaching teeth, 114
Cauterization, 229, 293, 408, 446
after hemorrhage, 372
in abscess cases, 446, 448, 469
Cautery, actual, 122
electric, 379
Cavity, excavation of, 339, 340
gingival, 336, 341
packing of, for bleaching, 491
preparation of, 159, 161, 329, 346
painless, 335, 340
sealing of, 341
sensitive, 295, 378
sterilization of, mechanical, 365
varnish, 122
Cement, copper phosphate, 95
for sealing, 346, 436
zinc oxychlorid, 97, 471, 476
phosphate, 211
Cementosis, 296, 532
Cementum exposed, cauterizing of, 229
irritation from, 348, 518, 532
sensitive, 100
Centigrade scale, 294
Cephaëlin, 256, 523
Cerates, 22
Chafing, powder for, 141
Chair, dental, dread of, 174
Chalk, precipitated, 40
prepared, 40
Chancre, syphilitic, 77, 89, 112, 543
Chancroids, 112
Change of life, 532
Chapped hands, 133, 138
Charcoal, animal purified, 66
as deodorant, 66
poultice, 23
Chartæ, 23
Chemical incompatibility, 319
Chemico-mechanical cleansing of canal 399
process, 404, 446
Chemistry, principles in, 319
of animal tissue, 387
of pulp tissue, 386, 391
Chewing, effect of, on saliva, 261
Chilblains, 191
Childhood, spasmodic disorders of, 170
Children, dosage for, 31
febrile affections of, 254
handling of, 382, 383
hypersensitive dentin in, 336
pulp removal in, 382
Children's teeth, cement for, 95
treatment of, 466
Chinosol, 78
Chip-blower, 433
Chips, clearing away of, 295
Chloral camphor, 170
hydrate, 32, 169, 171, 185, 537
as hypnotic, 170
poisoning by, 170
Chloramin-T, 79, 81
Chlorazene, 81
Chlorbutanol, 156
Chlorcosane, 82
Chloretone, 156
Chlorin, 107
nascent, 489
Chlorinated antiseptics, 83
lime, 107, 489
soda, 108
Chloroform, 160
as analgesic, 161, 337, 338
contraindications for, 162
dangers of, 161, 338
habit, 162
in canal-filling, 475, 478
narcosis, 68
physiologic action of, 161
therapeutics of, 161
use of, cautions, 161
Chloropercha, 140, 161, 430
Chlorosis, 204, 236
Cholagogue, 221, 232, 243
Cholera morbus, 238
Christian Science, 299
Chromic acid, 118
Chromium trioxid, 118
Cicatricial tissue, 410, 414
Cinchona, 167
Cinchonidin and cinchonin, 167
Cinchonism, 168, 169
Cineol, 55, 57, 474
Cinnamic aldehyd, 55
Cinnamon, oil of, 55, 237
water spray, 189, 509
Circulation, pericemental, 579
Citrus aurantium and vulgaris, 266

Classification of medicines, 33
Cleanliness of mouth, 546
Climate, influence of, on drug action, 33
Clinical, history and diet, 283
observation on dentinoid, 481
signs, 410
Cloves, oil of, 56
Coagulating agents, 365, 395
Coal-tar antipyretics, 166
Coca, 144
Cocain, action of, paralyzant, 146
anesthesia, fatalities from, 146
local, 145
as protoplasmic poison, 335, 367
by hypodermic, author's formula for, 151
combined with adrenalin, 154
with arsenic, 149
experiments in, 145, 146
habit, 148
hydrochlorid, 6, 144, 145, 152
billets, 152
dosage of, maximum, 151
hypodermic use of, 149
solutions of, 151
idiosyncrasy, 31, 148, 150
points, 152, 366
poisoning, 147, 150
treatment of, 148, 189, 321
sloughing from, 150
substitutes for, 152
susceptibility to, 147
therapeutics of, 149, 152
Cocaina, 145
Cocoa, 145, 192
Coco-vitamin, 193, 289
Codein, 176, 177
Cod-liver oil, action of, restorative, 213
in emaciating diseases, 213
source of vitamin D, 282, 290
Coffee in narcotic poisoning, 178, 188, 191
Coil, dry-cell vibrating, 297, 397
Cold, application of, to sensitive dentin, 332
as therapeutic agent, 294
cream, 43, 268
in the head, 260
physical law concerning, 336
sores, 97, 140, 542
Colds, treatment of, 58, 266, 299, 332, 542
Colitis due to periodontoclasia, 504
Collapse, 27, 29, 194, 199
from anesthetics, 198, 251
Collargol, 102
Collodion, 14, 139, 542
cantharidal, 140
flexible, 140
styptic, 82, 140
Collyrium, 95, 317
Color molecule, breaking up of, 490
of urine, 558
of tooth, 369, 370
preservation of, 369, 378, 484
restoration of, 397, 484
by caustic pyrozone, 469, 494
Coloring agent, 269, 509, 512
Colycynth, 245
fatal irritation from, 246
Comedones, 105
Communicable diseases, 466
Compound licorice powder, 236
Compounds, ferrous, 207
miscellaneous, 7
Compressed air, 295, 332, 334
Condensation of bone, 393
Conduction anesthesia, 28, 146, 154, 335, 455, 458, 499, 520
Cone flower, 227
Cones, fitting of, 475, 476
Confections, 20
senna, 233, 234, 235
Confidence of patient, 299, 508
Congestion, cerebral, croton oil in, 244
Conjunctivitis, 95, 101
Conservativeness of dentists, 498
Constipation, chronic, 134, 233, 234, 235, 236, 246, 247
due to rhubarb, 237
in children, 234
Constructive diseases, 348, 351
Consumptives, 549
Convalescence in exhaustive diseases, 223
Convolvulin, 245
Convulsions in childhood, 170, 254
in strychnin poisoning, 184
in tetanus, 196
Convulsions, relief of, 196
Cooperation of physicians and dentists, 466
Copper cement for filling, 458
oxid, 95
solution, 561
sulphate, 94, 255
as emetic, 210
in actinomycosis, 551
Coriander oil, 235, 265
Corns, removal of, 52, 113
Correctives, 262
Corrosive sublimate, 221
as an alterative, 220
poisons, 190
Corrosives, 109
Coryza involving antrum, 497
treatment of, 131, 136, 180, 198, 254
wool, 132
Cotton for filling root-canals, 471
Cottonoid rolls, 514
Cottonseed oil, 135
Cough, 138, 180, 199
mixtures, 257
Counterirritants, 38, 64, 121, 123, 179, 191
refrigerant, 433
Counterirritation, remedial effect of, 122
Cracks in feet and hands, 100
Cream of tartar, 248
Creosote, 72, 395, 396, 471
Cresol as diluent, 396
as disinfectant, 71
Croton oil, 244

Croup, 131
Crown, gold, 348, 350, 501
perfect, mutilation of, 579
porcelain, 348, 421, 447
setting of, painful, 149
Crowned teeth, abscesses of, 421
Crowning, dangers of, 363
Crystal violet and brilliant green, 414
Cudbear, tincture of, 269, 511, 513
Curettement of abscess, 447, 454, 462, 468, 521
hemorrhage in, 455
incision for, 455
Currents, electric, 297
Cusps, grinding of, 433
Cyanosis from nitrous oxid, 338
Cystic fluid differentiated from serum, 444
Cysts, periapical, 444, 454
dentigerous, 497

DAKIN'S solutions, 79, 81, 555
Dandruff, 236
Dead pulp, diagnosis of, 397, 498
"Dead," "devital," or "nonvital teeth," 392
Death from cancer, 557
chloroform, 161, 162, 338
cocain, 146
ethyl chlorid, 144
hydrogen dioxid, 76
opium, 180
Decay of teeth, rapid, 212, 329, 348, 557
Deciduous molar roots, resorption of, 382
filling canals, 480
teeth, abscess in, 466
pulps of, gangrenous, 466
removed, 382
Decimal system, 303, 307
Decomposition of pulp tissue, 386, 390, 391
Decoctions, 16
Deficiency diseases, 284
Deformities, nasal, 137
Delirium tremens, 188
Demulcents, 36, 132, 191
Dental liniment, 433, 434
author's, 534
Dental pastes, potassium chlorate in, 251
pulp, diseases of, 344, 362
sterilization, 322, 326
therapeutics, 327
Dentifrices, 36, 212
Dentin, artificial, 361
blood in, 370
desensitizing of, 144, 154, 334, 339, 341
hypersensitive, 329, 330
infected, sterilizing of, 222, 224
obtunding of, 59, 160, 295, 298
by cold, 332
by heat, 331
by physical agents, 331
protection of, 489
secondary, 348, 381
sensitive, 59, 160, 295, 298, 331
Dentin, sensitive, treatment of, 98, 339
sensitiveness of, thermal, 329
sterilization of, 224, 340, 356, 365
Dentinoid, 212
for filling the canals of pulpless teeth, 478
for protecting the dental pulp, 359
Dentist and physician, relations of, 410, 529
cooperation of, 327, 535
right of, to prescribe, 311, 537
Dentistry, painless, 28, 30, 149, 329
Dentition, temporary, 170, 175, 193, 285
Denture, red-rubber, 219
Denuded roots, 449, 519
Deodorants, 36, 45, 76
Deoxidation, 108
Deposit encircling tooth, 504
removal of, 509, 510, 517, 522
salivary, 505
Dermatitis, 155
Desensitization of dentin, 144, 154, 334, 339, 341
Desensitizing paste, 61, 154, 159, 339, 343
on exposed cementum, 577
precautions in using, 341
Desquamation due to formaldehyd, 74
Destructive diseases, 352
Devitalization of pulp, 364, 374, 375
by formocresol, 378
technic of, 377
Dextrins and dextrose, 268
Diabetes mellitus, 225, 292
teeth in, 507
Diagnosis by radiogram, 296, 404
mistake in, 468, 578, 579
of dead pulps, 397
of diseases of dental pulp, 344
Dialyzed iron, 379, 385
Diaphoretics, 36, 253, 255
Diarrhea, 52, 160, 233, 237
inflammatory, 236, 238
treatment of, by salol, 52
Diastase, 231
Diathesis, hemorrhagic, 89
rheumatic, 507
uric acid, 252
Dichloramin-T, 80, 82, 365, 447, 489, 499, 553, 555
for periodontoclasia, 515
for sterilizing root canals, 407
Diet, faulty or deficient, 193, 278
of infants, 284
Digestants, 229, 230, 232
Digestive tract, toxins in, 540
Digitalein and digitalin, 194
Digitalis, 193
action of, cumulative, 194
physiologic, 194
as diuretic, 247
poisoning by, 195
preparations of, standardization of, 195
therapeutics of, 194
Digitin, digitonin and digitoxin, 193

Di-isobutyl-cresol-iodid, 62
Diluent of powders, 20
Diphtheria bacillus, 270, 466
Diphtheria, resorcin in, 65
toxins of, 270, 271
Dipsomaniacs, 188
Direct oxidation, 489
Discharge, syphilitic, 543
Disclosing solutions, 514
Discoloration of teeth, 86, 204, 469, 484, 488
by fracture, 494
by iron tannate, 379
by potassium permanganate, 84
causes of, 484, 485, 488
pink, 484
Disease, treatment of, rational, 327
Diseases, constructive, 348
and bacterial vaccines, 276
destructive, 352
Disinfectants, 36, 45, 82, 218, 473, 500
surgical, 78
Disinfection, 45
by alcohol, 325
by cresol, 71
by formaldehyd, 73
by mercury, 78, 221
in dentistry, 327
of hands, 106, 107
of rooms, 74
of site of operation, 327
of wounds, 80
terminal, 45, 75
Dispensatory, 5
Dissolution, 3
Di-thymol-di-iodid, 62
Diuretics, 37, 247
Dobell's solution, 316, 515
Donovan's solution, 223, 224, 225
Dosage, 31, 311
Dover's powder, 117, 180, 228, 257, 268
Drastics, 35, 232
Dressings, antiseptic, 24, 140, 443
fixed, 132
Drilling, dangers of, 330, 369
into innocent teeth, 445
of teeth, painless, 330, 332
Dropsy, general, 247, 252
Drug, definition of, 1, 4
Drug culture, 8
Drug-habit, 30
irritants, 429
poisoning, 137, 265, 278, 321
Drugs, action of, 2, 30, 331, 430
added to root-fillings, 472
administration of, 25
by hypodermic, 26
by inhalation, 30
by inunction, 29
by mouth, 25
by rectum, 30
intravenous, 29
race and, 33
time of, 33
antagonism of, 321
antidotes to, 320
chemic tests of, 320
coagulating, 392
Drugs, effects of, 2, 31, 430
cumulative, 31, 194
in pathologic conditions, 32
local, 142
for local use, 40
general, 40
incompatibility of, 319, 320, 321
inorganic and organic, 5
masking taste of, 138
miscellaneous group of, 200
neutral principles of, 6
sources of, 4
standardizing of, 193
to be prescribed alone, 320
vegetable, 4
Dry gangrene of pulp, 416
Dusting powder, 132, 157
Dysentery, amebic, 258, 523
tropical, 523
Dyspepsia, atonic, 182, 230
flatulent, 66
Dysphagia, 235

ECHAFOLTA, 227
in cases of infection, 437
Echinacea, 227, 228
therapeutics of, 228
Eczema, acute erythematous, 141
ointment for, 220
treatment of, by talc, 141
Edema of larynx, 554
Effervescent salts, 20, 437
Ehrlich's discovery of "606," 543, 544
Electrargol, 102
Electricity as a nerve stimulant, 297, 301
as therapeutic agent, 301, 333
in neuralgia, 535
Electric mouth lamp, 100, 296, 497
Elixirs, 14
Elongation of tooth, 429
Emboli, gaseous, a cause of death, 76
Emetics, 37, 255
ammonium alum, 92
in strychnin poisoning, 185
mustard, 125
tepid water, 258
Emetin, hemostatic action of, 524
hydrochlorid, 257
treatment in periodontoclasia, 522, 524
Emodin, 235
Emollients, 37, 132
Empirical therapeutics, 1
Emulsifying agents, 15, 137
Emulsin, 199
Emulsions, 15
Enamel, brilliancy of, 514
Encystment of root, 449
Endameba buccalis, 502, 522
histolytica, 522
Endocrinodontia, 291
Endocrinology, 291
End products, 485, 487
of pulp decomposition, 390, 395, 396
Enema, administration of, 30
Epidermic medication, 29

Epilepsy akin to alcoholism, 188
convulsions of, 175
Epinephrin, 90
Epispastics, 122
Epsom salt, 239, 242
Equimolecular concentration, 240
Ergot, 89
in pregnancy, 32
Eriodictyon, aromatic syrup of, 437
Erosions, 348
saliva in, 261
Eruptions, syphilitic, 545
Erythroxylon coca, 144
Eschar of sulphuric acid, 403
production of, 109
Escharotics, 37, 109
cautious use of, 120
desensitizing, 333
Esophagus, piercing of, 112, 190, 504
Essences, 11
Ether, 159
as analgesic, 337
contraindications of, 160
inflammability of, 159
inhalation of, 160
making of, 320
narcosis, 68
spray, 144, 160
Ethyl alcohol, 186
bromid, dangers of, 162
chlorid, 143, 294
as analgesic, 357
inflammable vapor of, 143
use of, fatal, 144
nitrite, spirit of, 254
Ethylene, 163
Eucain, 153
Eucalyptol, 57
and gutta-percha solution, 140
compound, 58, 405
formula for, 431
use of, for abscess, 433
for moistening canals, 430
solvent power of, 473, 474, 482
with thymol, 444
Eucapercha, 473, 482
Eugenol, 56, 264
for sensitive dentin, 337
Euroform paste, 63, 459
in abscess, 451
in arsenical poisoning, 385
Europhen, 62, 359, 451
Examination of urine, 558
Excementosis, 451
Excipient for pills, 21
Excitement, nervous, 172
Excoriations, 136
Excretions, stimulation of, 436
Exfoliation from arsenical poisoning, 376
Exophthalmic goiter, 283
Expectorants, 37
sedative, 259, 260
Experiments with phosphorus, 209
Explosion, caustic pyrozone, 493
ether, 159
nitric acid, 111
silver nitrate, 101
sulphuric acid, 111
External use, preparations for, 22
Extracellular toxins, 503
Extract, powdered, 18
Extraction of teeth by specialists, 158
deciduous, 161
hemorrhage following, 86
in antral diseases, 498
in cases of abscess, 439
in mercurial poisoning, 217
painful sockets after, 157
painless, 153
unnecessary, 465
products by, 15, 16
Extracts, assay of, 18
pilular, 18
solid, 16, 18
Exudates, absorption of, 124
Eyes of baby, sore, 100
Eye-wash, boric acid, 47

FACIAL neuralgia, 532, 533, 538
Fahrenheit scale, 294
Family physician, case of syphilis referred to, 544, 545
collaboration with, 327, 335
Faradic current, 297
Fat a product of putrefaction, 492
as source of energy, 214
digestion of, 214
supply of, in body, 214
Fats in dentistry, 7
Federal Anti-Narcotic Law, 30, 149, 152 180, 537
Narcotic Law, 30, 149
record blank, 536
Feet, hyperidrosis of, 86, 93
Fehling's solution, 561
Fennel, 265
Ferment, albuminous, 231
Fermentation, acids of, 42
in the mouth, 268, 517
Ferric chlorid, 206
compound, 204, 205
hydroxid with magnesium oxid, 207
hypophosphite, 208
oxid a cause of discoloration, 492
subsulphate, 206
Ferrous carbonate, 207
compound, 204, 205
iodid, 208
ions, 205
sulphate, 205
Ferrum dialysatum, 205
Fever sores, 542
Fiber, devitalizing, 419
Fibrin ferments, 91
Field of operation, dry, 198
Fig as a laxative, 234
Filling materials, drugs added to, 472
metallic, 348
of teeth, painless, 330
root-canals, 392, 471, 476, 478
in deciduous teeth, 480
Filter, charcoal as, 66
Filth disease, 552
Fissures, protective for, 139
Fistulæ, salivary, 118
Fixed oils, 7

Flatus, prevention of, 262
Flavored masses, 21
Flavoring agents, 11, 264, 265
Flaxseed poultice and tea, 135
Flowers of sulphur, 238
Fluid extracts, 18
Fluxes, 49
Foci of infection, 275, 442, 462, 507, 531
  removal of, 525
Fomentations, 24
Food and Drugs Act, National, 4, 152
Food and Diet, 278, 292, 506
Foods, definition of, 38, 203
  preservative of, 48
Foot-bath in pericementitis, 437
Foramina, sealing of, 477
Foreign bodies, expulsion of, 255
Formaldehyd, 73
  as antidote for arsenic, 378
  chemic changes produced by, 395
  gas, generation of, 396
  treatment of gangrenous pulp, 395
  use of, cautious, 443
Formalin, 73
Formocresol, 398
  dressing, 398, 417
  for devitalization, 378
  in treatment of abscess, 442
    pulpal, 416
    purulent, 407
  remedy, 72, 74
Formol, 73
Fowler's solution, 224, 225, 247, 267
Fractional sterilization, 322, 323
Fracture of jaw, 296, 494
Fractures, pain of, 179
Fuller's earth, 141
Fumes of phosphorus, 208
Fumigation, 46
Fungous growths, 112, 113, 551
Fusibility of preparations, 22

GALLIC acid, 86, 87
  Galvanic current, 297
Gamboge, 245
Gangrene of pulp, 354, 416, 435, 466, 485
  in deciduous teeth, 466
  treatment of, 466
Gangrenous root-canals, 114, 392, 468, 485, 487
Gargle, chinosol, 79
  for sore throat, 95, 317
Gas in alimentary canal, 262
Gases, conversion of, into liquids and solids, 73
  noxious, from chloroform, 161
  of decomposition, 396, 398
Gastric catarrh, 99, 242
  digestion, 211, 214
  juice, 42
  stimulants, 198, 200
  ulcer, 99, 230, 410, 504
    due to pyorrhea, 503
Gaultheria, 237
Gauze, euroform, 453
  medicated, 25, 81
Gelatin capsules, 169
Gelseminin sulphate, 202
Gelsemium, 202
  poisoning, 202
Genito-urinary diseases, suppurative, 74
Gentian, 198
Gentio picrin, 199
Germicides, 37, 46, 365
Germs of disease, 270
Gin, Holland, 186
Ginger, preparations of, 263
Gingivitis, 504, 513
  acute, ulcerous, 101, 552
  distinguished from periodontoclasia, 553
  in periodontoclasia, 510
  interstitial, 502
Glands, mucous, stimulation of, 261
  suprarenal, 90
  thyroid, 91
Glass containers, disinfection of, 324
Glonoin, 196
Gloves, rubber, 547
Glucose, 268
Glucosides, 6
Gluttony, 278
Glycerin, 133, 512
Glycerite of tannic acid, 86
Glycerites, 14
Glyceryl trinitrate, 196
Glycyrrhiza and Glycyrrhizin, 138
Gold and sodium chloride, 229
  crowns, 348
  inlay, 469
  scrap, refining of, 251
Gonorrhea of mouth, 557
Gout, use of lithium for, 252
Gouty diathesis, 225
Granulation tissue, 298, 459
Granulations, exuberant, 93, 100, 120
  treatment of, 77
Granulomas, dental, 112, 121, 271, 275, 392, 403
  non-purulent, 403, 404, 416
  treated by ionization, 407, 408
Grape juice, pure, fermented, 186
Green soap, tincture of, 44, 135
Gregory's powder, 237
Growths, small, removal of, 207
  within bony canals, 531
Guaiacol, 73
Gummata, 547
Gums, brushing of, 514
  derivation of, 7
  hypertrophy of, 113, 118, 121, 379, 381
  inflamed, 88, 97, 133, 270, 384
  lacerated, 63, 66
  recession of, 42, 505, 506
  slitting of, 520
  sloughing of, 384
  solubility of, 7, 319
  spongy, 67, 86, 88, 501
Gun cotton, 139
Gutta-percha, 140
  addition of drugs to, 472
  and eucalyptol solution, 140
  cones, 477

Gutta-percha, filling, 58, 383
for deciduous teeth, 466
for root-canals, 458, 471, 477, 479
hermetic sealing with, 493
points, 324, 423, 474
solvents, 430, 472
use of, injudicious, 346
white base-plate, 473, 491

HABIT, drug, 30
Hæmatoxylon campechianum, 88
Halazone, 84
Hallberg on metric system, 305, 306
Hamamelis Virginiana, 88
Hands, chapped, 133, 138
disinfection of, 106, 107, 474
lotion for, 268
of dentist, abraded, 140
punctured, 140
Harrison Narcotic Act, 31
Headache, 59, 131, 183, 193
nervous, 536
Healing by first intention, 66
Heart failure, sudden, 192
stimulants, 184
tobacco, 183
Healing process, 450, 459, 460
Heat, application of, 278, 331
as a counterirritant, 123
as a disinfectant, 79
in the treatment of pericementitis, 434
Hemagulen, 92
Hematics, 39, 203
Hematinics, 203, 205, 207
Hematoxylon, 88
Hemoglobin in tubuli, 484
Hemophilia, 89, 98
Hemorrhage after extraction of teeth, 206
removal of hypertrophied gum, 379
capillary, 189
intestinal, 87
persistent, 98
post-partum, 89
prevention of, 91, 372, 373
profuse, after pulp removal, 113, 370, 372
arrest of, 98
secondary, 372
small, 92, 98
treatment of, with salt solution, 200
Hemostatics, 39, 84
Henbane, 180
Herbs used for drugs, 8
Heroin, 177, 180
Herpes gingivalis, 542
labialis, 542
Hexamethylenamin, 75
Highmore, antrum of, 495
Hoarseness, 138
Hine, Dr. C. L., splint suggested by, 526
Hoffmann's anodyne, 160
Honeys, 14, 234
Horse, antitoxin from, 272
Howe's method, 40, 45, 100, 410, 415
Hydrated aluminum silicate, 523
chloral, 169
Hydrastin and hydrastina, 89, 90
hydrochlorid, 89
Hydrastis canadensis, 89
preparations of, 90
Hydragogues, 36, 232, 241
Hydrargyrum, 216
Hydrated chloral, 169
Hydrobromic ether, 162
Hydrochloric acid, 112, 403
Hydrocyanic acid, 199
Hydrofluoric acid, 121
Hydrogen dioxid, 75, 105
as a bleaching agent, 492
as a mouth-wash, 76
ethereal solution of, 492
explosion of, 493
in pulp removal, 370
sulphid in pulp decomposition, 392, 393
Hyoscin hydrobromid, 180
Hyoscyamin hydrobromid, 180
Hyoscyamus, 180, 181
Hyperacidity of stomach, 42
Hyperemia of pulp, 353, 354
treatment of, 354, 359
production of, 298
Hyperidrosis of feet and hands, 86, 93, 198
Hyperisotonic solutions, 240
Hypersensitive dentin, 329
Hypertrophy of gums, 113, 118, 122, 379
of pulp tissue, 118, 382
process, alveolar, 443, 445
Hyperthyroidism, 173
Hypnotics, 37, 169
Hypnotism, 300
Hypodermic injection, fright due to, 151
into vein, 27
technic of, 28
irrigation of sinus, 446
medication, indications for, 26
syringe, varieties of, 27
Hypoisotonic solution, 241
Hypophosphites, syrup of, 208, 213

ICE, application of, 294
as local anesthetic, 144
-bag, 420
Idiosyncrasy to cocain, 147, 150
to drugs, 31
to potassium iodid, 215
to quinin, 169
Iletin, 530
Immunity, natural and acquired, active and passive, 271, 274, 442
Impacted teeth, 296, 532
Impotence, functional, 210
Impression, compound, 526
Incompatibility, chemic and physical, 319, 320
in prescriptions, 319
of antipyrin, 165
of potassium bromid, 175
of sodium bicarbonate, 42, 320
of tannic acid, 87

Incompatibility, physiologic, 321
therapeutic, 321
Incompatible drugs, list of, 320
Indian hemp, 181
Indirect oxidation, 489
Infection, alveolar, germs found in, 451
danger of self, 546
focus of, 96
removal of, 409, 416, 462
hematogenous, 468
lymphogeneous, 468
low grade, 532
mixed, due to extraction, 439, 451, 522
from ulcer formation, 123
of face and jaws, 141
of mucous patches, 545
open wound, 326, 459
root-end, 121
septic, a cause of sloughing, 150
from hypodermic injections, 27
streptococcus, 274
syphilitic, 542, 546, 548
Infectious diseases, therapy of, 270, 276
Infiltration anesthesia, 28, 455
Inflammation as natural process, 436
catarrhal, 497
of pulp, 353
pericemental, 140
Infusions, 16
Inhalation of arsenic, in dust, 116
of chloroform, 161, 338
of drugs or liquids, 30
of ether, 160
of ethyl chlorid, 143
of nitrite of amyl, 196
Injections, hypodermic, 27
intraneural, 118
intravenous, 200
Injury from careless instrumentation, 509
Insect bites, 134
Insomnia, 170, 172, 173
from grief, relieved by sulphonal, 172
Insulin, 530
Instrument tray, 511
Instruments, boiling of, 42, 45
for curettement, 456, 457, 458
for pulp removal, 368
for scaling, 510
in syphilitic cases, 547
Logan-Buckley, 509–512, 517
metal, effect of mercury on, 222, 224
oxygen on, 491
rusting of, 323
sterilization of, 42, 78, 224, 323, 456, 475, 511
by paraform, 75
by resorcinol, 65
Interosseous anesthesia, 28
Intestines, absorption of drugs in, 26
Intoxication, acute, 187
Inunction, 28
Iodin, 61
as antiseptic, 61
as counterirritant, 63
Iodin, as disinfectant, 325
compound solution of, 384, 434
discoloration, 62, 63
poisoning, 134
stimulation by, 384, 459, 521
use of, in bone affections, 521
Iodism, 63, 215
Iodoform, 61
action of, 63
Iodol, 62
Ionic medication, 122
theory, 408
Ionization, 122, 297, 408
Ipecac, 256
root, preparations of, 522
Iron carbonate, 207
compounds, 204, 205
deficiency of, 204
dialysed, 207
objections to, 379, 385
injurious to teeth, 208
iodid, 206
masked, 205
metallic, 203, 204
organic, 204
perchlorid, 206
quinin, and strychnin phosphate, 537
reduced, 207
tannate, 379
Irritants, 38, 121, 429
mechanical, 431
Irritation, reflex peripheral, 531
Islands of Langerhans, 530
Isopilocarpin, 253
Isotonic solutions, 149, 201, 241
Itching, 59

JABORANDI, 253
Jalap, preparations of, 246
Japanese bibulous paper, 475
Jaundice, catarrhal, 242, 255
Jaws, operations about, 156
Jeweler's rouge, 513
Joint affections, 190, 191, 276
Juices of plants as drugs, 8

KALIUM, 120
Kaolin, 133, 141
Keefe's suction apparatus, 299
Kirk's bleaching mixture, 108
thymophen, 60
reduction process, 490
Koch's laws or postulates, 270
Koller, introduction of cocain by, 145
Krameria, preparations of, 87
triandra, 87

LABARRAQUE'S solution, 107, 489, 490
Laboratory, biologic, 270
pathologic, 541
Lactation, medication during, 33, 291
Lactic acid, 114, 268
Lactose, 268
Lanolin, 136
Laryngitis, 65, 86, 92
Larynx, edema of, 190, 556

Latin, medical, 313
Laudanum, 176, 180
Laughing gas, 158
Lavender, preparations of, 267
Laxatives, 35, 232
Lead acetate, 93, 94
filling, 459, 479
poisoning, 94, 216, 242
croton oil in, 244
Leeching, 299
Lemon juice in scurvy, 266, 288
Leprosy, 258
Leucocytes, action of, 299
Leucoplakia buccalis, 550, 551
Licorice, 236
"Life-saver," 473
Light as remedial agent, 295, 333, 550
Lime, chlorinated, 107
liniment, 15
Lime-salts, 211
Lime-water, 41, 212, 220
Liniments, 15, 317
ammonia, 190
author's, 534
belladonna, 197
camphor, 130
chloroform, 161
dental, formula for, 433
for pericementitis, 129
soft soap, 135
Truman s 535
Linimentum calcis, 41, 135
Linseed, 135
Lips, dry and cracked, 96
Liquid soldering fluid, 50
Liquids, poisonous, of decomposition, 395
Liquor antisepticus, 48, 60, 575
formula for, 516
cresolis compositus, 71
Lithium carbonate, 252
citrate, 252
Liver, sluggish, 220
Logan-Buckley instruments, 509–512, 517
Logan crown, 518
Loose teeth, prognosis for, 508, 527, 529
Lozenges, 20
"L.-Suprarenin Synthetic," 90
Lucodescent light, 295
Ludwig's angina, 556
Lugol's solution, 61, 215, 434
Lumpy-jaw, 551
Lunar caustic, 99
Lupus vulgaris, 296, 541
Lycopodium, 141
Lysol, 71, 72

MACE, 262
Magnesia, calcined, 43
heavy and light, 43
Magnesium carbonate, 43
citrate, 243
solution of, formula for, 436
oxid, 43
silicate, 140
sulphate, 239, 241
Malaria, salvarsan in, 225
quinin a specific in, 169, 543
Malignant growths, pain of, 179, 557
Malt, 230, 231
Malted liquors, 187
Manna and mannite, 233
Marshmallow, 138
Massage in dentistry, 298, 514, 515
Masses, 21
Materia medica, definition of, 1
Maxilla, fracture of, 494
Maxillary sinus, relation of molar roots to, 496, 498
sinusitis, 101
Measures, approximate, 303
Mechanical irritants, 429, 431
Medical Latin, 313
Medication, epidermic, 28
hypodermic, 26
ionic, 121
Medicines, classification of, 33
definition of, 1
Melancholia, hypnotic in, 183
Membrane, pericemental, 429
semipermeable, 240
Menstruation and canker sores, 543
Menstruum, 16
Mental healing, 299
Menthol for headache, 59
for sensitive dentin, 337
Mercurial stomatitis, 217, 250, 317, 548
Mercuric chlorid, 78, 221, 222
iodid, red, 222
poisons, 219
sulphate-ethylenediamin, 223
Mercurol, 223
Mercurous chlorid, mild, 226
iodid, yellow, 223
Mercury, 216
absorption of, 217
action of, cumulative, 217
physiologic, 217
as specific for syphilis, 218, 544, 545, 546
atoxylate of, 544
bichlorid, 221
biniodid, 222
compounds of, 218, 219
organic, 218
in dental amalgams, 219
inunctions of, 218, 219
iodid, green, 223
nucleinate, 223
poisoning by, 217, 219, 548
protiodid, 223
succinimid, 525
systemic disturbance from, 219
therapeutics of, 218
Metal die, 141
Metallic potassium and sodium, 399, 401
Metaphosphoric acid, 210
Meter as unit of linear measure, 304
Methemoglobin, 165
Methyl meta-amino-para-oxybenzoate, 156
Methyl trichlorid, 160
Metric system, 301, 303
advantages of, 306
measures of capacity, 305
weights, 305

Metrology, 301
Microorganisms, 270, 354
Migraine, 171, 182, 192
Milk, pasteurized, 284
Milk of sulphur, 238
Mineral acid, neutralizing of, 111
poisoning, 112
waters, natural, 242
Mitchell's "rest cure," 298
Mixtures, 15
of solids, 20
Model, coating of, 141
wax, 527
Moisture, removal of, 474
in canals, 401, 430
Molars, pericemental abscess of, 469
Money, decimal system of, 304
Monochloracetic acid, 113
Monsel's salt and solution, 206
Morphin, action of, local, 178
anhydrous, 176
for neuralgia, 536
habit, 179
prescription for, 536
salts of, 177
Mouth and stomach, relations of, 540
acids in, 40
aphthous sore, 101
bacteria in, 355, 435
diseases of, 329, 540
disinfection of, 51
hygiene of, 355, 546
after operation, 459
infection of, gonorrheal, 557
-lamp, electric, 497
rubber sore, 88
secretions of, 261
syphilitic symptoms in, 545
tissues of, hard, 329
soft, 540
-washes, antiseptic, 133
astringent, 84, 261, 514
cinnamon, 55
dangers of, 76
for periodontoclasia, 516, 517
Mucilages, 16
Mucoperiosteum, penetration of, 459
Mucous membrane, hypodermic injection through, 29
inflammation of, 94, 100, 139
morbid conditions of, 216
oral, 90, 540, 546
tuberculosis of, 549
ulceration of, 114
patches, syphilitic, 113, 118, 545
Mucus, secretion of, 259
Mustard, black and white, 124
blisters from, 125
paper, 23
Mydriatics, 38
Myocardial degeneration, 225
Myotics, 38
Myristica, 262
Myrosin, 125
Myrrh, 67
Myrtol, 260

NARCEIN, 176
Narcotic poisoning, 95, 125, 193, 198
electricity in, 297
Narcotics, 38, 176
federal law concerning, 30, 149, 152, 180, 536, 537
Narcotile, 143
Narcotin, 176
Nasal cavity, abscess under, 453, 454
deformities, correction of, 137
Nausea due to cocain, 151
from ipecac, 523
in taking impressions, 73, 149
National Formulary, 4
food and drug act, 152
tuberculosis ass'n, 549
Natrium, 119
Narcosis, 68, 176, 179
Necrosis in gingivitis, 553
maxillary, 210
of bone, 111, 137, 452, 467, 548
Neosalvarsan, 115, 226, 543
Neothesin, 155, 337, 346
Nerve blocking, 27, 146, 155, 538
Nerve, inflammation of, chronic, 531
sheath, inflammation of, 531
tissue, regeneration of, 538, 539
Neuralgia, 531
agonizing, 538
causes of, 531
due to anemia, 226
general diseases, 531
local diseases, 531
pulp nodule, 351
facial, 129, 130, 532
intractable, 531
malarial, 537
obscure cause of, 348
of fifth nerve, 210
persistent, 118
rheumatic, 124, 126, 163, 181, 536
treatment of, 199, 203, 318, 532
anodyne, 535, 536
by alcohol and cocain anesthesia, 539
by counterirritation, 140, 161
by injections of alcohol, 538
by liniments, 534, 535
by menthol, 59
by morphin, 179, 536
by quinin, 169
by salicylates, 52, 54
general, 535
local, 534
medicinal, 534
surgical, 538
systemic, 535
trifacial, 171, 202, 532
trigeminal, 123
with periodontoclasia, 199
Neurasthenia, phosphorus in, 210
Neuritis, 245
Neurocain, 152
Nervine, 203
Nervous diseases, treated by arsenic, 114
prostration, massage in, 298
system, action of alcohol on, 187

Nicotin poisoning, 182
Niter paper inhalations, 251, 252
sweet spirit of, 255
Nitric acid, 111, 558
Nitrites as heart stimulants, 195
Nitrogen monoxid, 158
Nitroglycerin, 196, 437
Nitrous oxid, 158
as analgesic, 338
combined with oxygen, 499
Nodules, pulp, 111, 382
Nosophen, 62
Novocain hydrochlorid, 153
as local anesthetic, 29, 153
for hypersensitive dentin, 336
Nutgall, 85
Nutmeg, 262
Nutrition, effect of calcium phosphate on, 211
Nux vomica, 183, 186, 235

OCCLUSION, faulty, 432, 506, 532
Odontalgia, 57
Odor, significance of, 443, 497
"Official" remedies, 4
Oil, camphorated, 131
cod-liver, 213
cottonseed, 130
croton, 244, 246
of cajuput, 54, 474
of cassia, 55
of cinnamon, 55
of cloves, 56, 422
for sensitive dentin, 337
of eucalyptus, 57
commercial, 430
of myristica, 262
of myrtle, 259
of peppermint, 58
of theobroma, 145
of thyme, 60
of turpentine, 126
Oils, essential, 6, 13
fixed, 6
volatile, 6, 54, 263
Ointment, tannic acid, 86
Ointments, 22, 23, 63, 459, 460
Oleate of cocain, 336
Oleates, 14
Oleoresins, natural, 6, 19
pharmaceutic, 19
Olive oil, 134
Operations about jaws, 155
bloodless, 456
minor, anesthesia in, 143, 159, 162
Ophthalmia neonatorum, 100
Opisthotonos, 184, 185
Opium, 176
action of, physiological, 177
as analgesic, 338
contraindications, for, 180
denarcotized, 176
elimination of, 178
habit, 178, 179, 180
poisoning, 178, 179, 180
distinguished from alcoholism, 187
treatment of, 179
Opsonic index, 525
theory, 275
Opsonins, 273, 299
Orange, preparations of, 266
Organic dioxids, 106
peroxids, 106
Orthoform, 156
Orthophosphoric acid, 210
Osmic acid, 119, 538
Osmium tetroxid, 119
Osmosis, process of, 240
Osseous system, action of phosphorus on, 209
tissues, tonic for, 210
Osteitis, 112
Osteoma, cause of, 445
Osteomalacia, 210, 212, 291
Osteomyelitis, 393, 439, 457, 506, 507
Overwork a cause of insomnia, 172
Oxalic acid, 107, 489
Oxidation as bleaching process, 489
Oxidizing agents, direct, 103
indirect, 103, 107
mixture, 252
Oxids, metallic, solutions of, 14
Oxygen, 68
as a bleacher, 68
combined with nitrous oxid, 159
nascent, liberation of, 104, 493
power of, 492
Ozone, 68

PAIN after pulp removal, 432
control of, methods for, 330
from cutting of bone, 459
in septic pericementitis, 438
"killer," 179
of drilling, 295
relief of, by anodynes, 142
by opium, 179
by pyramidon, 167
immediate, 432
severe paroxysms of, 531, 534
Painless dentistry, 28, 30, 149, 329
Palate, soft, destroyed by gummata, 547
Pancreatin, 230
Papain, 231
Papaverin, 176
Paraffin filling for root-canals, 471
injections of, 137
oils, 82, 399
Paraform, 74
Paraformaldehyd, 74, 156
Paraldehyd, 172
Paralysis of fibrillæ, 335, 340
Paralyzant agents, 142
Parasiticide, 222, 239
Paregoric, 177
Parillin, 227
Parr's fluxed wax, 50
Parts-by-weight system, 301
Paste, antiseptic, 472, 473
arsenic trioxid, 376
desensitizing, 61, 154, 159, 339, 343
devitalizing, 136
for filling root-canals, 471
for pulp capping, 57

Paste, orthoform and europhen, 156
sodium dioxid and alcohol, 371
thymolized calcium phosphate, 358
Pasteurization, 46
Patches, leucoplakia, 550
mucous, 100, 114, 118, 545
Pearson's solution, 225
Pediculosis pubis, 219, 222
Pepper, black, 262
Peppermint, oil of, 58
water of, 237, 446
Pepsin, 229, 230
Percentage in solutions, 307
Pericemental abscess, 468, 470
therapeutics of, 468
membrane, circulation in, 519
regeneration of, 469
Pericementitis, apical, 74, 130, 430
causes of, 58, 366, 367, 429, 431
counterirritation in, 122, 124, 129, 161, 432
home remedies for, 433
nonseptic, due to irritants, 429
liniment for, 130
treatment of, 125, 429, 431
by aconite, 433
by heat, 433
septic, 429, 434
causes of, 434
diagnosis of, 434, 435
treatment of, by drugs, 435
by heat, 123
by menthol, 59
general, 435
local, 434
Periodontoclasia, 501, 530
active cause of, 502
blood count in, 503
classes of, 505
treatment of, 504, 507, 530
Periodontoma, 392
Persio, 269
Peruvian bark, yellow, 167
Petrolatum and petronol, 136
Pharmaceutic preparations, 11
Pharmacodynamics, 1
Pharmacology, definition of, 1
Pharmacopeia, United States, 4
Pharmacy, 3
Pharyngitis, 65, 87, 101, 113, 259, 504
chronic and subacute, 93, 259
Phenacetin, 166
Phenol, action of, 68, 69
as analgesic, 333
as local anodyne, 337
compound, 60, 357, 512
for hermetic sealing, 447
in pulp treatment, 345
poisoning, 51, 69, 242, 447
Phenolphthalein, 239
Phenolsulphonic acid, 110, 111
advantages of, 402, 404
as cleansing agent, 399
as stimulant, 444
in pulp removal, 371
in pus pockets, 521
in treatment of abscess, 447, 469
indications for, 112
Phenolsulphonic, neutralizing of, 453
syringe for, 453
Phenyl salicylate, 52
Phosphoric acid, 210
Phosphor-necrosis, protection against, 210
Phosphorus, 208
action of, physiologic, 209, 210
inflammability of, 209, 210
poisoning, 209
therapeutics of, 210
Physicians and dentists, harmonious work of, 327, 409, 523
Phthisis, treatment of, by arsenic, 115
by terebene, 127
Picropodophyllin, 246
Pigment a cause of discoloration, 485
Pills, 21, 316
aloes and iron, 235
cathartic compound, 220
rhubarb compound, 235
vegetable cathartic, 245
Pilocarpin, effect of atropin on, 253
Pilocarpus, 253
Pimenta, 264
Pinus palustris, 126, 127
Piperin, 262
Plants, parts of, used for drugs, 7
Plaster-of-Paris bandages, 24
Plasters, 23
capsicum, 125
mustard, 22
Plastic porcelain filling, 137
Plating solution, 229
Pockets, deep, elimination of, 520
lingual, 453, 460
pyorrheal, 99, 114, 502
curettement of, 517, 518, 525
location of, 520
Podophyllin and podophyllotoxin, 246
Podophyllum, 246
Poison, definition of, 3
tablets, 21
Poisoning, acetanilid, 165
aconite, 130
alcohol, 187
ammonia, 190
amyl nitrite, 195
arsenical, 43, 116, 117, 207, 208, 376
local, 384
aspirin, 52
atropin, 197, 198
bismuth, 99
by alkalies, 114
by corrosives, 120, 134, 137
by depressant drugs, 185, 194
by mineral acids, 41, 113
cantharides, 128, 129
caustic potash, 120
chloral, 169
cocain, 147, 321
digitalis, 195
gelsemium, 202
hydrofluoric acid, 121
iodin, 134
lead, 93
mercurial, 217, 219, 548

Poisoning, metallic, chronic, 218
narcotic, 94, 125, 198
nicotin, 182
opium, 178
oxalic acid, 40
paraldehyd, 173
phenol, 69, 242
phosphorus, fatal, 210, 506
potassium bromid, 173, 174
chlorate, 251
strychin, 184, 185, 188
Poisons, antagonists to, 35
expulsion, 255
Polishing of teeth, 513, 520
Polypi, nasal, removal of, 88, 497
Porcelain body, 141, 488
filling, 137, 343
jacket crowns, 348, 420
Posology, 31
Posture when inhaling chloroform, 338
Potash, caustic, 119
Potassium acetate, 249
and sodium, 119
metallic, 399
tartrate, 243
bicarbonate, 248
bitartrate, 249
bromid, 173, 174, 175, 185
carbonate, 248
chlorate, 250, 251
citrate, 249
dichromate, 119
hydroxid, 120
iodid, 215
action of, cumulative, 215
physiologic, 215
in tertiary syphilis, 460
ion, 249
nitrate, 252
permanganate, 77
in opium poisoning, 179
incompatibility of, 77
Poultices, 23
ice, 144
kaolin, 141
Powders, 20, 315
dusting, 133, 141
Practical cases, history of, 416
prescriptions, 315
treatment of, 417
Precipitates, formation of, 319
Pregnancy, a factor in dosage, 32, 212, 291
and ergot, 89
mouth secretions in, 44
purgation in, 32
Preparations for external use, 22
Prescription, basis of, 310
official formula in, 314
refilling of, 180
-writing, 308, 314
abbreviations in, 308
by the dentist, 312
in Latin, 313
Prescriptions, incompatibility in, 319, 320
practical, 315, 318
Pressure anesthesia, 29, 152, 364, 367, 368
for pulp removal, 368
instruments for, 368
from abnormal growths, 531
in pulp removal, 367
osmotic, 240
Prinz's isotonic solution, 150
Privies, deodorant for, 206
Probing for caries, 451
sinus, 445, 453
Procain, 153, 336, 539
Process, devitalization of, 384
exposed, after extraction, 63
removal of, surgical, 385
Products by extraction, 16
Prophylaxis, dental, 506, 553
in mouths of school children, 466
in periodontoclasia, 512
Proprietary local anesthetics, 153
Protargol, 102
Protectives, 132
Prothrombin, 92
Protozoön a cause of periodontoclasia, 502
Prune as a laxative, 234
Prunus virginiana, 199
Pruyn's method, 401
Psoriasis, simulation of, 74
Psychotherapy, 299
Psychrotin, 256
Ptomains in pulp decomposition, 389, 395
Ptyalin, secretion of, arrest of, 85
Ptyalism, 68, 87, 217, 548, 556
Pulmonary tuberculosis, 74, 549
Pulp, anesthesia of, 28, 29, 297, 335, 352
blood-vessels of, 344, 345
calcification, 381, 417
capping, factors in, 354, 356
pastes for, 57
technic of, 356, 357
chamber, opening of, 368, 378, 398
pus in, 398, 423
dead, diagnosis of, 296, 297, 353, 397
decomposition, 386, 390, 391
a cause of discoloration, 484
chemistry of, 386
end-products of, 73, 395, 399
delicacy of, 346, 357
devitalization of, 117, 180, 231, 344, 363
diseases of, destructive, 352
diagnosis of, 342, 344
exposure, 354, 355, 356
by accident, 419
in the young, 355
function of, 363
gangrene of, 416, 435, 466
diagnosis of, 354
in a child, 466
specific for, 72
treatment of, 418, 466
with oil of myrtle, 261
with phenolsulphonic acid, 111
with sinus, 445
hyperemia of, 353

Pulp, irritation of 345, 358
mechanical, 363
nodules, 111, 349, 351, 381, 432
in neuralgic case, 351
radiographs of, 350
normal, anatomy of, 344
sacrifice of, 352
partially alive, 415
pathology, 342
poisoning of, 378
remnant, destruction of, 105, 111, 120
removal, 114, 152, 342, 344, 364, 370, 517
after-treatment, 371
complications of, 379
from deciduous tooth, 382
indications for, 363, 517
painless, 372
septic, 354, 416
slow death of, 358
stimulation of, 54
tissue, decalcified, 159
digestion of, 231
tissue, hypertrophy of, 118, 381
chemistry of, 386
treatment of, 344
vital, removal of, 363
Pulpal abscess, 354, 416
Pulpitis, anodyne for, 171
associated with pericementitis, 373
diagnosis of, 355
treatment of, by phenol, 70
true, 353, 360
Pulpless teeth, complications of, 410
diagnosis of, 392
sequelæ of, 392
treatment of, 392, 398
by acid method, 403
by formocresol, 404
silver reduction, 40, 410, 415
Punctures, protective for, 139
Purgatives, 36, 232, 239
Purshianin, 232
Pus, burrowing of, 445
disposing of, 442
evacuation of, 228, 444, 449
from abscess, 442
mechanical, 446
formation, causes of, 435
checking of, 443, 444, 450
pockets, cauterization of, 521
pyorrheal, diseases due to, 503, 521, 550
examination of, 501
Putrescence, true, 416
Putrid sore throat, 77
Periodontoclasia, 501
a cause of pulp removal, 364
antiseptic in, 96
causes of, active and predisposing, 501
classes of, 504
systemic, 506, 529
cure of, 507, 520
deposits in, 504
extraction of teeth in, 507
gouty, 249
Periodontoclasia, mistaken for alveolar abscess, 519
percentage of cases of, 524
pus in, diseases traced to, 503
rheumatic, 54, 225, 249, 506
stimulation in, 114
systemic effects of, 502
treatment of, 507
acid, 111
by betanaphthol, 65
by cresol and lysol, 73
by emetin, 257
by iodin, 64
by lithium, 252
by mercury succinimid, 524
by ozone, 68
by suction, 298
by zinc oxid, 97
general, 529
local, 529
mechanical, 526
medicinal, 52, 514, 521
surgical, 509, 517
true, 505, 517
with indigestion, 515
with neuralgia, 199, 203
Pyorrhea astringent, author's, 134, 514
Pyorrheal pockets, 76
Pyramidon, 167, 537
Pyrophosphoric acid, 211
Pyrotechnics from sodium dioxid, 105

QUINIDIN, 168
Quinin, action of, on blood, 169
on white blood corpuscles, 437
and urea hydrochlorid, 169
as a tonic, 170
as specific for malaria, 170, 537
bisulphate, 438
elimination of, 169
idiosyncrasy to, 170
valerianate, 181
Quinsy, 228, 503

RACHITIS, 210, 212
Radiogram, value of, in dentistry, 296, 471
in diagnosis, 404, 443, 445, 449
Radiograms in operative cases, 460
interpretation of, 419
of nodules, 350
of pulpless tooth, 399
Radium salts, rays of, 297
Rarefied area, 393, 472
Rash, boric acid, 47
quinin, 169
Rational therapeutics, 1
Ray-fungus, 551
Rays, alpha, beta, and gamma, 297
Reaction of boric acid, 48
of saliva, 261
of sodium dioxid, 103
Recession of gum, 42, 506, 507
"Record blank" for narcotics, 149, 152
Rectum, medication by, 30
Reducing agents, 108, 490
for refining gold scrap, 252
Reduction, process of, 108, 489, 490

Reflex peripheral irritation, 531
Refrigerant agents, 142
Remedies, classes of, 2
definitions of, 34
desensitizing, 330
local, 40
other than drugs, 293
specific, 51
Research, institutions for, 465
Resins, derivation of, 6
precipitated, 19
preparations of, 17
solubility of, 319
Resistance, vital, lowered, 531
Resolution, 3
promotion of, 123
Resorcinol, 65
Resorption in cases of abscess, 448, 450
Respiration, artificial, 147, 148, 179
Respiratory apparatus, efficiency of, 196
centers, functional activity of, 196
failure, 148
stimulants, 196, 198
Restoratives, 38, 200, 203, 214, 229
Retainer for teeth, 527, 529
wax, directions for making, 527
Retractor, use of, 456
Rhein's ionic theory, 408
method of filling canals, 400
Rheumatism, 50
acute, 54, 249, 254
salicylic acid in, 52
chronic, 191, 223
due to pyorrheal infection, 507
muscular, 126, 127, 163
treatment of, by aspirin, 52
by salol, 52
Rhigolene spray, 144
Rhizome of plants, 7
Rhubarb, preparations of, 237
Ricinolein, 236
Ringer tablet "B," 200
Ring-worm, 65, 222, 238
Rochelle salt, 243
Roe, Prof. J. N., 558
Rōntgen ray, 296
Root amputation, 156
-canals, asepsis of, 431
enlargement of, 105
filling of, 96, 471
with chloropercha, 161
with various materials, 471
gangrenous, 46, 111, 119
sterilization, 119
tortuous, 105, 111
treatment of, 58
aseptic, 189
standard for, 415
with thymocamphen, 131
cementosed, 533, 534
decayed, 413
denuded, 519
encystment of, 451
-end, denuded, 450, 519
encapsulated, 475, 478
filling of, 458
infection of, 532
Root-end, roughening of, 448, 449
resorption of, 450
excision of, 454, 457, 519
-filling, asepsis in, 473
old, removal of, 405
pastes, 472
pus formation in, 443
surface, exposure of, 520
Roots of plants, 7
Rose, red, preparations of, 267
Rosin, 127, 472, 478, 482
Rubber dam, adjustment of, 198, 364, 403, 409, 474, 491
sore mouth, 87, 93
Rubefacients, 122

SACCHARIN, 268
Sacrifice of teeth, 441, 506
Sal ammoniac, 259
Salicylic acid, 51
Saline cathartics, 241, 437
Saliva, change in, 93
examination of, 261, 540
pus-laden, swallowing of, 507
Salivation, 217, 546, 548, 557
atropin for, 198
effect of, on teeth, 506
free, in periodontoclasia, 525
prevention of, 251
Salol, 52
Salophen, 53
Salt action, 149, 239
solution, 149, 239
physiologic, 30, 200, 421
Saltpeter, 251
Salts, effervescent, 20
soluble, 205
Salvarsan, 115, 218, 225, 543
contraindications of, 225
or "606," 225, 543
Saponin, 226
Sarsaparilla, 226
as alterative in syphilis, 226
compound syrup of, 236, 437
Sarsa-saponin, 226
Sassafras, 139
medulla, 264
Scabies, 50, 65, 239
Scalds, 41, 156
Scale salts, 205
Scaling, process of, 510
D. D. Smith's, 512
Scar tissue, 298
Schreier's alloy, use of, technic of, 399
Scopolamin hydrobromid, 180
Sealing, hermetic, 371, 449, 493
in root-canal work, 477
in of remedies, 346, 430
of cavity, 433
with cement, 436
Secretion, excessive, expulsion of, 255
gastric, antiseptic action of, 502
glandular, arrest of, 85
of serum, 444
Secretions, control of, 198
effects of opium on, 177
pilocarpin on, 253

Sedatives, 39, 182
Seidlitz powder, 243
Senna, 208, 235
Separating fluid, 49
Septicemia, treatment of, by echafolta, 228
Sequestra, exfoliation of, 439, 543, 548
removal of, 112
Serous membranes, inflammation of, 179
Serum antidiphthericum, 272
antipneumococcus, 273
antistaphylococcus, 273
antistreptococcus, 273
antitetanicum, 272
production of, 5
weeping of, 443
Serumal deposits, 505, 507, 530
Serums, action of, 273
"Setting" of paste, 358
Sex, a factor in dosage, 32, 178
Sexual appetite, 174
excess, 210
vitality, 182
Shaving emollient, 88, 93, 133
Shellac, 49
Shock, alcohol in, 189
from anesthetics, 198
from hemorrhage, 200, 292
"Shot-gun" prescription, 308
Shrinkage, 482
Sialogogues, 39, 260
Sight, accidental loss of, 510
Silver chlorid precipitate, 560
metallic, 99
nitrate, 99
as prophylactic, 334
nitrate, for babies' sore eyes, 100
neutralizing of, 320
preparations of, colloidal, 102
reduction, 410, 415
salts, action of sunlight on, 100, 296, 334
vitellin, 101
Sinalbin, 125
Sinapis nigra, 124
Sinigrin, 125
Sinus, apical, of bicuspid, 419
cauterizing of, 70, 71, 446
closed, 76
dento-alveolar, 99
discharging for several months, 448
establishment of, 446, 449
in alveolar abscess, 114, 445
irrigation of, 446
opening into mouth, 445
treatment of, by hydrogen dioxid, 75, 446
by trichloracetic acid, 114
tubercular, chronic, 99
weeping of, 448
Skin, hypodermic injection through, 28
inflammation of, 97, 139
lesions, 138
Sleep, narcotic, 176
Sleeping sickness, 544
Slippery elm, 139
Sloughing of tissue, causes of, 127, 150
from arsenic trioxid, 116
Smallpox vaccine, 274, 275
Smokers, gingivitis in, 552
mouths of, 550
Snake-bite, 189, 227
Soap, incompatability of, 46
soluble, 492
white castile, 45
Soapstone, 141
Sockets, painful, 157
Soda, caustic, poisoning by, 120, 399
chlorinated, 107
Sodiotheobromin salicylate, 193
Sodium benzoate, 51
bicarbonate, 41
incompatibility of, 42, 320
borate, 42
bromid, 174
dioxid, 104
as bleaching agent, 489, 490, 492
ice-water solution of, 490
hydroxid, 120
as a by-product, 103
iodid, 216
ion, 175
perborate, 76, 555
peroxid, 103
phenolsulphonate, 403
phosphate, 242, 437
pyroborate, 42
salicylate, 54
sulphate, 242, 403
Solids, mixtures of, 20
Solutions, 12
anesthetizing, 324, 366
antiseptic, 316, 357, 365
bichlorid of mercury, 221
concentration of, 240
cudbear, 510, 512
Dakin's 201
disclosing, 513
emetin hydrochlorid, 523
Fehling's, 561
hyperchlorous acid, 201
hyperisotonic, 241
hypertonic, 201
isotonic, 149, 201, 241
magnesium sulphate, 242
of non-volatile substances, 12
percentage in, 305
pharmaceutic, 11
prescriptions for, practical, 316
rosin, 127
salt, 30, 149, 200, 240, 421
sodium bicarbonate, 519
sodium dioxid, 103
true, 22
Solvent, chloroform as, 161, 482
eucalyptol as, 473, 474, 482
Somnifacients, 37, 169
Somnoform, 143, 162
Sores, open, 67
Spanish fly, 128
Spasms, relaxation of, 195
Spearmint, 263
Specific disease, 2, 542
gravity, 301, 558
of urine, 558
remedy, 169, 225

Spinal cord depressants, 173, 174
Spirillum, affections due to, 225, 226
Spinal cord depressants, 173
Spirillum, affections due to, 225
Spirits, 13, 186
aromatic, 13
of ether, compound, 160
of mindererus, 255
of nitrous ether, 255
Spirocheta in pyorrheal pus, 502
pallida, 218, 542, 544
Splints for teeth, 24, 527, 529
Splints for teeth, 24, 527
Spooner, use of arsenic by, 117, 374
Spore formation, 322
Sprains, 67, 88, 162, 298
Spray, alcohol, 439, 535
cinnamon, 55
cocain, 149
ether, 160, 332
ethyl chlorid, 294
rhigolene, 144
Spraying outfits, 514
Sputum of consumptives, 549
Squill, preparations of, 258, 260
Stain from silver nitrate, 101
ineradicable, 380
nitric acid, 111
removal of, 370
Staining agent, 88
Standardized vitamin products, 289
Standards for vitamin preparations, 285
Staphylococcus pyogenes, 435
aureus, 270
Starch, 134
Starvation, deficiency of fat in, 213
Steapsin, 231
Stearoptenes, 6, 59
Sterilization by filtration, 41
dental, 322, 474
by chemic agents, 323
by direct flame, 322
by dry and moist heat, 82, 323
by filtration, 46
by formaldehyd, 340, 341
by ionization, 408
by sublamin, 224
in pulp removal, 365
mechanical, 377
of dentin, 222, 356
of fingers, 367
of gutta percha points, 474
of hypodermic syringe, 27
of instruments, 42, 81, 224, 323, 455, 474, 511
responsibility for, 325
surgical, 46
Sterilizers, 84, 323
Stewart, Dr. Lee K., appliances of, 529
Stimulants, 39, 183
cardiac, 183
gastric, 198
respiratory, 196
restorative, 200
Stings, 134
Stock solutions, 324
Stomach, absorption of drugs in, 25
cancer of, 157
Stomach, disorders of, 230
hyperacidity of, 44, 46
irritant material in, 257
-pump, dangers of, 112
rupture of, 112
washing of, 139
Stomachics, 198
Stomatitis, argyrol in, 101
chronic, 100
mercurial, 217, 251, 317, 548
treatment of, 43, 58, 60, 96, 217
ulcerative, 57, 65, 67, 94, 95, 97, 228
Stopping, temporary, use of, 436
Streptococcus decomposition, 399
fecalis, 424
infection, 74
pyogenes, 435
longus, 504
pyorrheal, in feces, 502
salivarius, 424
vaccine, 274
viridans, 270, 399, 424
in periodontoclasia, 502, 503
Strontium iodid, 216
Strychnin, 184
as alkaloid of nux vomica, 183
physiological action of, 184
poisoning, 184, 195
diagnostic sign in, 185
sedatives in, 170
treatment of, 185
therapeutics of, 185
value of, in poisoning by depressants, 185
Stupe, turpentine, 127
Styptics, 39, 84
Sublamin, 223
"Submarine gardens," 61
Succinic dioxid, 106
Suction, hyperemia produced by, 298
Sudorifics, 36, 253
Sugar of milk, 268
Suggestion in treatment of disease, 299
Sulphonal, hypnotic action of, 171
poisoning by, 171
Sulphonmethane, 171
Sulphur, action of, physiologic, 238
in parasitic diseases, 238
lotum, 238
poisoning in match factories, 210
precipitated, 238
sublimatum, 238
Sulphurated calcium, 228
Sulphuric acid, 109, 399, 447, 490
action of, corrosive, 403
free, in phenolsulphonic acid, 447
in pulp removal, 365
in treatment of pulpless teeth, 402
therapeutics of, 110
Sulphurous acid, 35, 36, 108, 238
Sunburns, 156
Sunlight, effect of, on silver salts, 100, 296, 334
Suppositories, 23
glycerin, 133

Suppuration, arrest of, 229
in wounds, 65
Suppurative pericementitis, 435
Suprarenal gland, 90
Suprarenin, 90
Surgery in alveolar abscess, 454
in antral diseases, 498
major, nitrous oxid in, 159
Surgical asepsis, 122
shock, 292
sterility, 399
Sweat, clammy, 293
glands, activity of, 254
Sweating, excessive, 189, 254
Sweet oil, 134
Swelling due to abscesses, 420
Sylvester's artificial respiration, 148, 179
Syncope, 131, 189, 194, 196
Synthetic drugs, 5
products, 537
substitutes for cocain, 152
Syphilis, 2, 542
cure of, 547
diagnosis of, certain, 546
differentiated from gingivitis, 553
germ of, 542
infection of, 546
primary, 543
diagnosis and treatment of, 543
secondary, 215, 218, 251, 545
diagnosis and treatment of, 545
specific for, 225, 547
symptoms of, 542
tertiary, 223, 547
potassium iodid in, 215
treatment of, by arsenic, 114, 544
by mercury, 218, 222, 223
by "606," 218
Syphilitic conditions, iron iodid in, 208
mucous patches, 545
Syringe for phenolsulphonic acid, 453
Syrups, 13
Systemic diseases, origin of, 274, 275, 529

TABLETS, 21
alcresta ipecac, 256
corrosive sublimate, 21, 221
Ringer, 200
Talc, purified, 140
Tamarind, 233
Tannic acid, 35, 85, 87, 379
in krameria, 87
use of, objections to, 379
Tartar emetic, 258
solvent, 522
Teeth, anesthetization of, 145
artificial, 522
bleaching of, 77, 102, 105, 108, 113, 213, 485
bridged, 341, 349, 529
care of, 429, 515
cleanliness of, 546
coalescing of, 533
discoloration of, 369, 484, 492
dropping out of, 505
erosion of, 44
Teeth, eruption of, 163
examination of, in match factories, 210
exfoliation of, 376
extraction of, 87, 136, 143
needless, 410, 441, 506
painless, 149, 152
fracture of, 296
impacted, 296, 532, 533
loose, in periodontoclasia, 506, 507
support for, 528
lost, replacing of, 528
pink staining of, 484
replantation of, 521
scaling of, 70, 510
shortening of, 528
sound, extraction of, 534
whitening of, 76
Temperature, fever, reduction of, 163, 189
influence of, 33
Terebene, 127
Terpenes, 7
Test, chemic, for sodium dioxid, 491
heat, 558
nitric acid, 558
pulp vitality, 397
Tetanus, convulsions of, 170, 196
distinguished from strychnin poisoning, 185
toxins of, 270, 271
Tetra-iodo-phenol-phthalein, 62
Tetra-iodo-pyrrol, 62
Thebain, 176
Theobroma, 145
Theobromin, 192
Therapeutics, definition of, 1
practical, 327
preventive, 345
Therapy, successful, 327
Thermal sensitiveness, 329, 330, 340
Thermometric scale, 294
Thirst, allaying of, 211
Throat, diseases of, 234
Throat, sore, 87, 88, 95, 96, 113, 138, 139
putrid, 77
Thromboplastin, 92
Thrush, 42
treatment of, 43, 77
Thyme, oil of, 60
Thymocamphen, 61, 131
Thymol, action of, 60, 357
in eucalyptol, 140
iodid, 62, 313
Thymolized calcium phosphate, 358, 366
Thymophen, 61
Thyroid glands, desiccated, 91
diseases of, 64
Tic douloureux, therapeutics of, 538, 539
Tincture of opium, camphorated, 177
Tinctures, assay of, 15
use of, by dentists, 16
Tissue in cavity, nature of, 381
laceration of, 150
waste, 228

Tissues after cauterization, 405
constringing of, 515
of mouth, hard, 329
not associated with the teeth, 540
soft, 540
sloughing of, 150
Tobacco, 182
Tolerance of drugs, 31, 178
Toluene, 268
Tongue, cancer of, 76
enlargement of, 548
growths of, 557
Tonics, 38, 203
quinin, 169
spring, 139, 265
Tonsillitis, follicular, 228
Tonsils, enlarged, 95
Tooth, anatomic structure of, 331
bacterial growth on, 512
-pastes, base of, 41
for periodontoclasia, 514
powders, base of, 41
for general use, 315
-structure, disinfection of, 324
exposed, 100
sterilization of, 322
vital, opening of, 469
Toothache during devitalization, 376
jumping, 360
relief of, by chewing tobacco, 183
treatment of, 74, 353
Toxicology, definition of, 1, 2
Toxins, absorption of, 502
extracellular, 271, 503
in digestive tract, 540
in pulp decomposition, 395
intracellular, 270
Tragacanth, 137
Trauma a cause of antral disease, 497
Trench mouth, 552, 553
Trichloracetic acid, 37, 114, 334, 450
Tricresol, 71, 396
Trifacial neuralgia, 532
Trigeminal neuralgia, 532
Trional, 172
Trioxymethylen, 74, 334
Troches, 20, 88
ammonium chlorid, 259
tannic acid, 86
Tropacocain hydrohlorid, 152
Troy weight, 301, 302
Truman's, 535
Trypsin, 230
Tubercle bacillus, entrance of, into body, 549
Tuberculosis, 549
cod-liver oil in, 213
death rate in, 549
pulmonary, 73, 225
treatment of, 223, 226, 549
Tumor, apical, 459
Turpentine, 126, 127, 210
Typhoid fever, intestinal antiseptic in, 106, 188
vaccine, 276

ULCERATION, lupous, 114, 541
tuberculous, 114, 549
Ulcers, 65, 97, 100, 166, 541, 555
chancrous, 541
duodenal, 42
dusting powder for, 141
gastric, 42
gingival, 550
in the mouth, 541
indolent, 90, 92, 93, 113, 118
phagedenic, 111
sluggish, 63
syphilitic, 65, 220, 541, 543
tubercular, 549
Unit, of diphtheria and tetanus antitoxin, 272
United States Pharmacopeia, IX, 3
previous to 1880, 301
Urea hydrochlorid and quinin, 169
nitrate precipitate, 559
Uremia, acute, 254
convulsions in, 196
distinguished from alcoholism, 187
Uric acid precipitate, 559
Urine, albumin in, 530
alkalinity of, 247, 249
analysis of, 561
chlorids in, 559
effects of potassium on, 249
examination of, 558
mercury in, 217
phosphates in, 560
reaction of, 558
secretion of, 247, 249
solids of, 558, 559
specific gravity of, 558
sugar in, 530, 560
sulphates in, 560
urates in, 559
urea in, 559
Urotropin, 75

VACCINES, autogenous, 5, 271, 274
bacterial, 274, 275
mixed and stock, 274
use of, in periodontoclasia, 525
Valerianic acid, 202, 203
Vallet's mass, 207
Vanilla, 267
Vaselin, liquid, 136
Vault of mouth in abscess cases, 453
Vegetable drugs, 5, 7
alkaloids, 389
cathartics, 241
salts, 241, 249
Vehicles for drugs, 20, 21, 22, 310
Vein, air injected into, 27
Venous hyperemia, 353
Vermifuges, 34
Vesicants, 122, 170
Vesication, 62, 190, 294
Vibrating coil, 396
Vincent's angina or infection, 554, 555
Vinegars, 16
Vital pulp, removal of, 363
resistance, lowered, 531
Vitality of tooth after desensitizing, 343
Vitamins, 279, 284
sources of A, B, C, D, and E, 279, 280

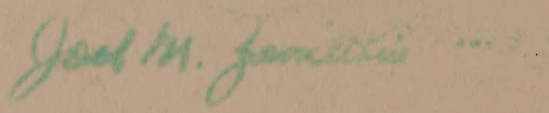
Vitamins, deficient diets, results of in, A, B, C and D, 280, 283
need for available preparations, 285
standardized products, 289
tests for A, B, C, and D, unit, 192
Vitriol, white, 95
green, 205
Volatile oils, 6, 54
prunus virginiana, 199
substances, solutions of, 12, 13
Volume of drugs, 17, 19
Volstead act, 148, 166, 189
Vomiting induced by apomorphin, 256
lime-water for, 41
Vital resistance, lowering of, 531

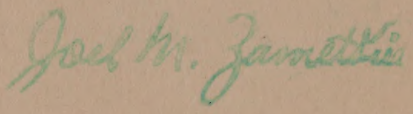
WARTS, removal of, 51, 112, 114
Washed sulphur, 238
Wassermann reaction, 543
Waters, aromatic and medicated, 11
Wax models, 527
Weight of drugs, 18, 19
Weights and measures, English, equivalents to, 305
Whisky, 186, 202, 537
Whooping-cough, 65, 163, 170
Wild cherry, syrup of, 199
Wine measure, 302
Wines, 15, 186, 187
Wires, diagnostic, 417, 419
Witch-hazel, 88
Wood charcoal, 66
Wool fat, purified, 136
Wounds, aseptic, 139
healing of, 66
incised, 86
infected, 80, 200, 296
lacerated, 86
packing of, 99, 459
painful, 156
protected by gutta-percha, 140
sloughing, 65, 119
Wright's hypertonic solution, 80

X-RAYS in diagnosis of abscess, 441, 454, 465, 497
of neuralgia, 532
of pulpless teeth, 417, 420
in disease of antrum, 497
in root-canal work, 478
in therapeutics, 296
Xylene, 405
Xylol, 405, 417, 418

YELLOW cinchona, 167
Yerba santa, 437

ZINC chlorid as a dangerous caustic, 97, 333, 395, 471
in treatment of cavity, 333
iodid, 97
ointment with calomel, 220
oxid, 96, 358, 471
oxychlorid cement, 97
phenolsulphonate, 96
sulphate, 95
sulphocarbolate, 96





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